D.W. ALLEY & Associates aquatic biology

2015 DRAFT SUMMARY REPORT− Juvenile Steelhead Densities in the San Lorenzo, Soquel, Aptos and Corralitos Watersheds, Santa Cruz County, CA

Fall Creek Flowing from Left to Right under Stream-Side Redwood

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Prepared For the

Santa Cruz County Environmental Health Department
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Funding From the

San Lorenzo Valley Water District, Soquel Creek Water District, Santa Cruz City Water Department, Scotts Valley Water District, Cities of Capitola and Watsonville and the County of Santa Cruz

June 2016 **Project # 200-13a**

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A. EXECUTIVE SUMMARY

In fall 2015, 4 Santa Cruz County watersheds were sampled for juvenile steelhead to compare juvenile abundance and habitat conditions with past years. Watersheds included the San Lorenzo River, Soquel Creek, Aptos Creek and Corralitos Creek. Pajaro Lagoon was also sampled. Thanks to local water agencies and municipalities, we have sampled the San Lorenzo annually since 1994 except for 2002. We have sampled Soquel Creek annually since 1997 and in 1994. Annual sampling of Aptos and Corralitos creeks began in 2006, with previous sampling of Aptos and Corralitos in 1981 and Corralitos in 1994.

<u>i. Steelhead Abundance in All Watersheds</u>

WY2015 streamflows in spring and early summer were much below the median streamflow statistic after a second very dry, mild winter in a row. Most rain and stormflows came in December, prior to the main adult steelhead spawning season. Another 5-10 day period of elevated streamflow occurred in early February, with 2-3 more very small stormflows in April. Thus, adult spawning migration was restricted to narrow windows, as had been the case in 2014. In the San Lorenzo drainage there was evidence of limited adult access to some upper tributary sites as indicated by very small YOY densities. Those included upper Boulder, upper Fall, middle Branciforte and Lompico Creeks, along with Newell Creek.

Young-of-the-year (YOY) densities were generally greater in 2015 than in 2014, but were still below average at most sites except in the middle Soquel drainage. Watersheds were dominated by small, slow-growing YOY with very few yearlings present.

Densities of the important Size Class II and III steelhead (soon-to-smolt) were generally rated below average in all 4 watersheds in 2015 (**Tables S-1 and S-2** *below*). The "very poor" rating was given to 13 of 40 sampling sites. In the San Lorenzo drainage in 2015, ratings of sampling sites based on density and size of soon-to-smolt juveniles declined at 8 of 24 steelhead sites and improved at only 2 sites rated "good" (Zayante 13c and Bean 14b). Only 4 of 24 wetted steelhead sites were rated "fair" or "good" and 6 were rated the lowest at "very poor." Upper Bean 14c went dry in 2015, as it had in 2014, with high densities of YOY present beforehand.

In the Soquel drainage in 2015, only 1 site was rated as high as "fair" (East Branch Soquel 13a below Mill Pond). Unfortunately 75% of that reach down to the West Branch confluence went dry, as it had in 2014. The remainder of the 7 sampled sites were rated mostly "very poor" (4) with one "poor" and one "below average." Site #16 in the Soquel Demonstration Forest went dry, as it had in 2014.

In Aptos Creek in 2015, the juvenile steelhead population was very low. Juvenile densities have spiraled down since 2010 to their lowest YOY and soon-to-smolt densities in 11 years of sampling. Yearlings were absent at the upper Aptos #4 site. Lower Aptos #3 had the highest soon-to-smolt rating of "below average," and upper Aptos #4 was rated "poor."

Adult steelhead successfully passed above diversion dams on Browns and Corralitos creeks in 2015. YOY densities at upper Corralitos Site 9 above the Corralitos Creek dam and upper Browns Site 2 were the second and third highest between the 6 sites sampled. The Corralitos sub-watershed had the best overall soon-to-smolt ratings in 2015. Half of the sites were rated below average (4), with the others rated fair (4), as was the case in 2014. Fair ratings were achieved because some sites had a few large yearling and older juveniles that kicked their ratings up to the "fair" rating, though the density of soon-to-smolt juveniles was low throughout.

Table S-1. Sampling Site Ratings in 2006–2015, based on Soon-to-Smolt Sized Steelhead Densities.

Year	Very Poor	Poor	Below Average	Fair	Good	Very Good
2006 (n=34)	1	6	5	11	10	1
2007 (n=37)	5	2	12	12	6	0
2008 (n=36)	5 (+ 1 dry)	6	9	10	6	0
2009 (n=37)	2 (+ 1 dry)	4	11	13	6	1
2010 (n=39)	0	1	9	16	12	1
2011 (n=37)	1	2	7	18	8	1
2012 (n=38)	2 (+ 1 dry)	1	6	9	17	3
2013 (n=38)	5 (+ 1 dry)	6	10	9	7	1
2014 (n=39)	6 (+ 2 dry)	10	13	8	2	0
2015 (n=40)	13 (+ 2 dry)	7	9	9	2	0

Table S-2. Rating of Steelhead Rearing Habitat For Small, Central Coastal Streams.* (From Smith 1982.)

1. **Very Poor**- less than 2 potential smolt-sized** fish per 100 ft of stream.
2. **Poor***** - from 2 to 4 " " "
3. **Below Average** - 4 to 8 " " "
4. **Fair** - 8 to 16 " " "
5. **Good** - 16 to 32 " " "
6. **Very Good** - 32 to 64 " " "
7. **Excellent** - 64 or more " " "

* Drainages sampled included the Pajaro, Soquel and San Lorenzo systems, as well as other smaller Santa Cruz County coastal streams. Nine drainages were sampled at over 106 sites.

** Potential smolt-sized fish were at least 3 inches (75 mm) Standard Length at fall sampling and would be large enough to smolt the following spring.

***The average standard length for potential smolt-sized fish was calculated for each site. If the average was less than 89 mm SL, then the density rating according to density alone was reduced one level. If the average was more than 102 mm SL, then the rating was increased one level.

Comparisons between indices of Size Class II and III abundance declined from the slightly above median baseflow year 2010 to the dry year of 2015 in watersheds where calculations were possible. For the San Lorenzo watershed, the total reach indices for 18 reaches (not including the lagoon) were 21,000 (2010), 7,800 (2014) and 7,500 (2015) for Size Class II and III juveniles. The 2015 index was 36% of the 2010 index. For the Soquel watershed, the reach index total for 8 reaches (not including the lagoon) was 3,800 (2010), 880 (2014) and 580 (2015) for Size Class II and III juveniles. The 2015 index was only 15% of the 2010 index. For the Corralitos sub-watershed in the abundance indices for Size Class II and III juveniles for 6 reaches (excluding Shinglemill Gulch) were 3,000 in 2010, 2,000 in 2014 and 1,000 in 2015. The 2015 reach index total was only one third the 2010 index.

Four factors may explain the much below average YOY densities at most sites in all 4 of our watersheds. The first factor was likely low adult returns during the previous winter/spring. Seven of the last 9 years have been on the dry side, including 2012− 2014, which has resulted in slower juvenile growth rates leading to smaller smolt populations and individual smolt size. The cumulative effect of multiple dry years has likely reduced juvenile survival to adulthood and adult returns. Trapping data from Scott Creek indicated a slight annual increase but still relatively low adult steelhead return in winter 2014-2015, where adult escapement estimates in water years 2006─2015 were 219, 259, 293, 126, 109, 214, 167, 50 and 86, respectively (**Joseph Kiernan, NOAA Fisheries, personal communication**). The adult coho escapement estimate was 163 for water year 2015 in Scott Creek, resulting from 31,000 coho salmon hatchery smolts released in 2013. The total 2014-15 winter/spring adult steelhead count on the Carmel River at San Clemente Dam was only 7 adult fish. Excluding the 2013-2014 winter, when the river did not reach the ocean, 2015 had the lowest adult count since 1991. Adult estimates at San Clemente Dam in water years 2006−2015 were 368, 222, 412, 95, 157, 452, 470, 249, 0 and 7, respectively (**Chaney, 2015**).

In the San Lorenzo drainage, the three sites with the highest YOY densities were middle Zayante 13c (above average), upper Zayante 13d (near but below average) and lower Bean Creek 14a (below average), with below average densities elsewhere. In the Soquel drainage, the only above average YOY densities occurred at the 2 upper mainstem sites (#10 and #12). The lower mainstem had very low YOY densities. Limited spawning of a likely very small adult population was also observed in the Corralitos sub-watershed, where YOY densities were widely varying between sites and mostly below average, with the highest densities occurring at Corralitos Site 1 below Corralitos Dam and upper Browns Site 2 above the Browns Valley Creek Dam. No steelhead were captured in Pajaro Lagoon. In the Aptos system, the continued well-below average YOY density in 2015 was attributable to a potentially very small adult steelhead population. Aptos Lagoon went unsampled in 2015, with the assumption that CDFW staff would sample it instead.

A second likely factor contributing to low 2015 YOY densities in the San Lorenzo and other watersheds was that adult steelhead spawning passage was restricted to narrow windows of time. Low YOY steelhead density in some upper tributary sites was indicative of this condition. Low YOY densities occurred in the upper mainstem Site 12a, upper Boulder 17b, upper Fall 15b, Lompico 13e and middle Branciforte 21b. Natural and man-made, low-flow passage impediments existed in the mainstem San Lorenzo. Natural and man-made, low-flow passage impediments existed in Fall Creek upstream of the fish ladder. If many of the remnant flashboard dam abutments with associated walls and openings collect instream wood in the future, they may become very significant impediments even in wetter winters, as they may have been in the past. These often low flow impediments may significantly inhibit coho recovery if not addressed, because entire year classes may be weakened if adult access to the watershed is largely prevented when early winter storms are lacking. The cold water refuges required for coho rearing are located in the upper mainstem and tributaries of the upper watershed, where access must be insured. In the Branciforte sub-watershed, more than 6 impediments that will impede adult salmonid passage during mild winters were identified, including the Branciforte flood control channel (**Kittleson 2015a**). At least 6 impediments that will impede adult salmonid passage during mild winters were present in the lower and middle mainstem San Lorenzo, including the Barker's Dam between the Erwin Way bridges (**Alley et al. 2004**). At least 6 potentially significant impediments during mild winters were present in the upper mainstem above the Boulder Creek confluence, including the flashboard dam abutment upstream of the Brimblecom Road Bridge (**Kittleson 2015b**). The low YOY densities in the upper mainstem San Lorenzo near Waterman Gap, and until 2015 at Teihl Road, leads one to believe that a passage impediment periodically develops after especially wet years, perhaps logs collecting on remnant flashboard dams. Though slightly higher YOY density at Bear 18a and sightings of adults spawning in upper Bear Creek in 2015, the near absence of YOY at the Bear Creek site in 2013 and 2014 indicated that the flashboard dam abutment on lower Bear Creek near Lanktree Bridge is a significant passage impediment when wood collects on it.

In the Soquel drainage, the primary passage impediments were Girl Scout Falls I and II on the West Branch. Few adults spawned above Girl Scout Falls I in 2015, evidenced by below average YOY density in the reach above. But we suspect that Girl Scout Falls II is a complete passage barrier in most years.

In the Aptos drainage, Valencia Creek has one potential passage impediment that is the baffled culvert near the mouth (under Highway 1). In 2014 and 2015, baseflow receded to near summertime flow between storm events, making it questionable if the baffles worked at low flows. An adult was observed in the fish ladder at Soquel Avenue in 2015 (**K. Kittleson pers. comm.**), perhaps because it was having difficulty passing with debris in the ladder. Furthermore, with extremely poor pool development after substantial sedimentation of Valencia Creek (perhaps occurring during the wet 2011 winter), with its long stretches of shallow run habitat below Valencia Road culvert, the stream channel, in general, may have been difficult for adult steelhead to pass.

Adult steelhead passage from the Bay to the monitored reaches of Corralitos and Browns creeks after December 2014 may have been restricted to just one 5-7 day period in early February. This February storm period provided a peak flow of about 500 cfs at Freedom, CA, with an open sandbar at the mouth of the Pajaro River likely between December and February and longer. YOY densities were higher in 2015 than 2014 in Corralitos and Browns creeks, indicating better spawning access and passage above the fish ladders on each creek.

A third likely factor contributing to low 2015 YOY densities was insufficient winter/spring baseflow to provide much spawning success or good egg incubation, resulting in poor egg survival during rapidly declining streamflow after storms passed. Between stormflows, streamflows declined to near summertime levels (streamflow in the 15−30 cfs range at Big Trees gage in the San Lorenzo for much of the February−April egg incubation period). Water percolation through spawning gravels to oxygenate eggs and remove metabolic wastes would have been much reduced at such low baseflows. Pool tail-outs have the best quality spawning gravel and fastest percolation rates, located just before the pools' hydraulic breaks. But under the low streamflows in 2015, these areas were too shallow for spawning, and adult steelhead likely moved further upstream into the pools beyond the breaks to find sufficient depth in which to spawn. However, most pools in the Santa Cruz Mountains have a high sand component, and the spawning fish likely resorted to spawning in more sandy substrate further upstream of the hydraulic break under these low flow conditions (**J. Smith pers. observation from 1988**). Also, the high sand component in the spawning gravels would further impede water percolation and oxygenation of eggs. This would reduce egg survival.

A fourth likely factor contributing to low YOY densities was reduced rearing habitat quality for juveniles that resulted from reduced streamflow, higher water temperature, shallower depth, limited escape cover and less food for YOY. This likely caused starvation of many YOY where spawning was successful but competition was higher. The averaged mean monthly streamflows for May−September in the San Lorenzo and Soquel watersheds were the second lowest in the past 19 years since 1997 (**Figure B-45** *below*). The preponderance of small YOY (except where their density was very low) and small Size Class II yearlings throughout the watersheds (except at some Corralitos sites) indicated slow growth rate in 2015. Furthermore, Corralitos Creek was still recovering from the Summit Fire of 2008 that caused high sedimentation to Corralitos Creek during the 2009-2010 winter, mostly downstream of Eureka Gulch. Habitat typing in Reaches 5 and 6 in 2015 indicated that conditions had not improved since 2012, and pool scouring was still very limited due to still highly sedimented conditions. This contributed to poor rearing conditions for YOY survival, along with very low baseflows (less food) upstream of Rider Creek confluence.

Higher water temperature increased food requirements for juvenile steelhead in 2015, as it did in 2014, by increasing metabolic rate at a time when less food was available as insect drift. Slower water velocities and lower baseflow reduced insect drift rate and riffle insect production zones. 2015 temperature monitoring in San Lorenzo tributaries (Boulder, Fall and Zayante creeks) and in the middle mainstem San Lorenzo, downstream of Clear and Fall creek confluences, indicated that summer water temperatures were 2−3˚C warmer than in the wetter water year of 2005. Habitat typing data in 2015 indicated a smaller proportion of riffle habitat per stream length and less surface area in riffles for insect production due to narrower stream channels associated with lower baseflow, further reducing food supply for steelhead.

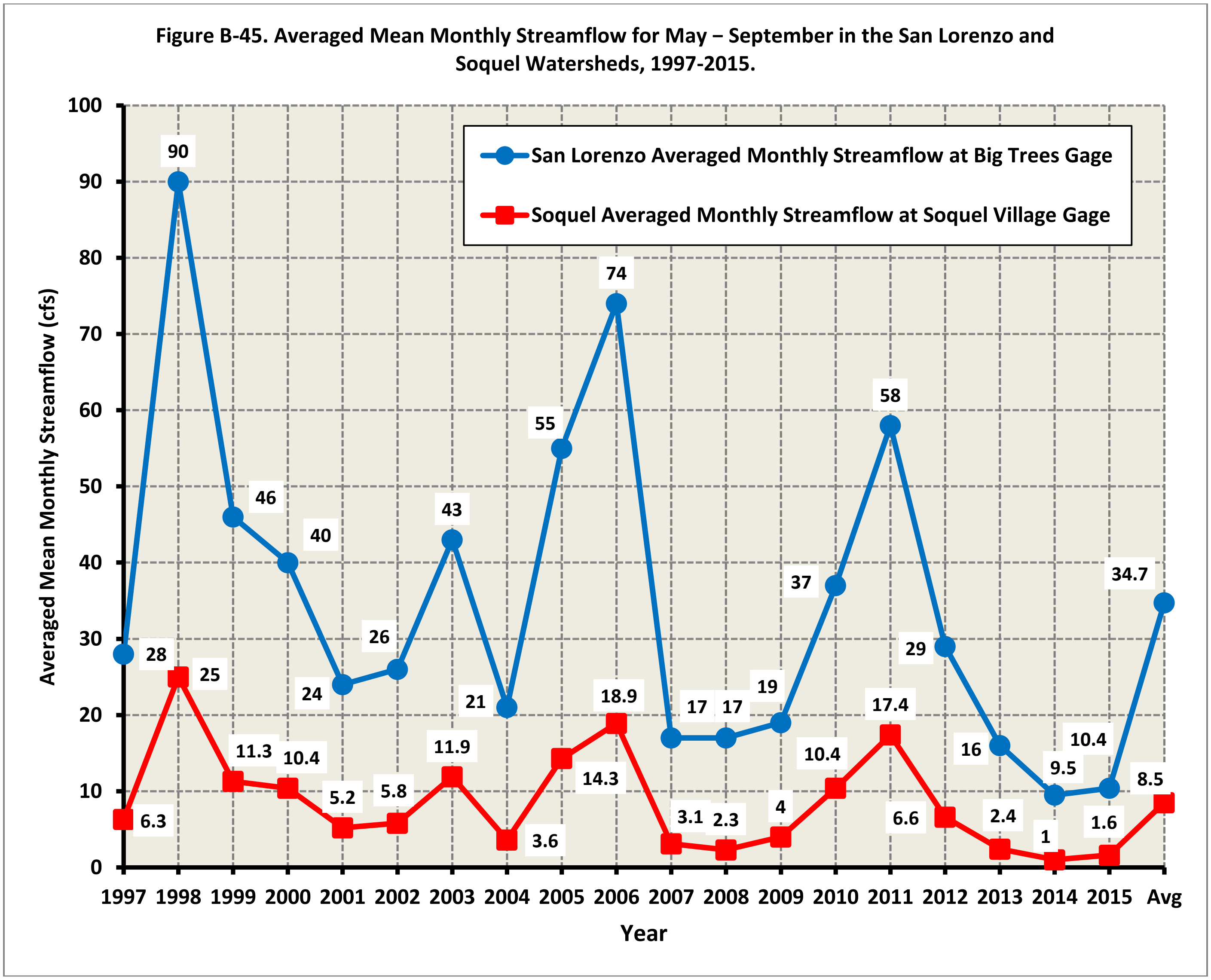

Figure B-45. Averaged Mean Monthly Streamflow for May – September in the San Lorenzo and Soquel Watersheds, 1997-2015.

B. INTRODUCTION

i. Scope of Work

In fall 2015, 4 Santa Cruz County watersheds were sampled for juvenile steelhead to primarily compare juvenile abundance with past years and habitat conditions at sampling sites and in limited habitat typed segments with those in 2014. Results from steelhead and habitat monitoring are used to guide watershed management and planning (including implementation of public works projects) and enhancement projects for species recovery. Refer to maps in **Appendix A** that delineate reaches and sampling sites. Tables and figures referenced in this summary report and not included may be found in **Appendix B**, the detailed analysis report. Hydrographs of all previous sampling years are included in **Appendix C**.

ii. Study Area

San Lorenzo River. The mainstem San Lorenzo River and 8 tributaries were sampled at 25 sites (10 mainstem and 15 tributary sites). Sampled tributaries included Branciforte, Zayante, Lompico, Bean, Fall, Newell, Boulder and Bear creeks. A new reach with sampling site was added to Zayante Creek (13i) above Mountain Charlie Gulch in 2015. An old reach in lower Bean Creek (14a) and sampling site were resumed in 2015, the first time since 2005. Eight half-mile segments were habitat typed in the San Lorenzo system to assess habitat conditions and select habitats of average quality to sample for fish density. For the remaining 17 sites, the 2014 sites were replicated for fish sampling, and depth and cover measurements were made at all sampling sites.

Soquel Creek. Soquel Creek and its branches were sampled at 7 sites (4 mainstem and 3 Branch sites). Three half-mile segments were habitat typed to assess habitat conditions and select habitats of average quality to sample for fish density. For the remaining 4 sites, the 2014 sites were replicated for fish sampling, and depth and cover measurements were made at all sampling sites.

Aptos Creek. Aptos Creek was sampled at two stream sites in 2015. No reaches were habitat typed. Therefore, the 2014 sites were replicated for fish sampling. Depth and cover measurements were made at both sampling sites.

Corralitos Creek. In the Corralitos sub-watershed of the Pajaro River drainage, fish sampling included 4 sites in Corralitos Creek and 2 sites in Browns Creek. Two associated half-mile reach segments habitat typed in Corralitos Creek, downstream and upstream of the diversion dam. Depth and cover measurements were made at all sampling sites.

Pajaro River Lagoon. The Pajaro River Lagoon was sampled for steelhead and tidewater goby, and water quality conditions were measured during sampling.

C. METHODS

i. Habitat Assessment

Refer to the Detailed Analysis **Appendix B** for more information. Section M-6 in **Appendix B** describes methods of assessing change in rearing habitat quality. Monitored watersheds included the San Lorenzo, Soquel, Aptos and Corralitos, a sub-watershed of the Pajaro River. Maps of sampling sites, habitat typed segments and reaches contained in **Appendix A** are provided below.

In the San Lorenzo and Soquel watersheds since 1998 and in the Aptos and Corralitos watersheds since 2006, half-mile reach segments were habitat-typed using a modified CDFG Level IV habitat inventory method in mainstem and tributary reaches; with fish sampling sites chosen within each segment based on average habitat conditions. See sampling methods in **Appendix B** for more details. Habitat types were classified according to the categories outlined in the California Salmonid Stream Habitat Restoration Manual (**Flosi et al. 1998**). Some habitat characteristics were estimated according to the manual's guidelines, including length, width, mean depth, maximum depth, shelter rating, substrate composition and tree canopy. Additional data were collected for escape cover, however, to better quantify it.

ii. Fish Sampling

Since 2006, fish abundance at sampling sites of average habitat quality in previously determined reach segments of 4 Santa Cruz County watersheds (San Lorenzo, Soquel, Aptos and Corralitos) have been compared to past years' abundances. Comparisons in this report go back to 1997 in the San Lorenzo and Soquel watersheds, 2006 in the Aptos watershed and 1981 in the Corralitos sub-watershed, although consecutive years did not begin until 2006 for the latter two watersheds. Previous steelhead sampling and habitat assessment was also completed in 1994−1996 in the San Lorenzo and in 1994 in Soquel. The proportion of habitat types sampled at each site within a reach was kept similar between years so that site fish densities could be compared between years in each reach. However, fish densities at sites did not necessarily reflect fish densities for entire reaches because the habitat proportions sampled were not exactly similar to the habitat proportions of the reach. In most cases, habitat proportions at sites were roughly similar to habitat proportions in reaches because sampling sites were more or less continuous, and lengths of each habitat type were roughly similar to others within reaches. However, in reaches where pools are less common, such as Reach 12a on the East Branch of Soquel Creek and Reach 2 in lower Valencia Creek, a higher proportion of pool habitat was sampled than exists in these respective reaches. More pool habitat was sampled because larger yearlings, almost exclusively utilize pool habitat in small streams, and changes in yearling densities in pools are the most important to monitor. In these two cases, site densities of yearlings were higher than reach densities. When reach abundance indices were calculated, reach proportions of habitats were factored in.

Electrofishing was used to measure steelhead abundance at sampling sites. Captured juvenile steelhead were grouped into two juvenile age classes and three size classes. Block nets were used at all sites to separate habitats during electrofishing. A three-pass depletion process was used to estimate fish densities.

If there was poor depletion in 3 passes, a fourth pass was performed, and the fish captured in 4 passes were assumed to be a total count in the habitat. Electrofishing mortality rate has been approximately 1% or less over the years. Snorkel-censusing was used in deeper pools that could not be electrofished at sites in the mainstem reaches 1−9 of the San Lorenzo River, downstream of the Boulder Creek confluence. Underwater censusing of deeper pools in reaches 1−9 was incorporated into density estimates with electrofishing data from more shallow, fastwater habitats.

Prior to 2006, juvenile steelhead abundance was estimated by reach. An index of juvenile steelhead population size was estimated by reach and by watershed in the San Lorenzo and Soquel drainages. Indices of adult steelhead population size were also calculated from indices of juvenile population size. Prior to 2006, estimated reach density and fish production could be compared between years and between reaches because fish densities by habitat type were extrapolated to reach density and an index of reach production with habitat proportions within reaches factored in. In 2014 and 2015, reach abundance indices were once again estimated for soon-to-smolt sized steelhead in the San Lorenzo, Soquel and Corralitos watersheds for juvenile populations in 2010, 2014 and 2015.

Pajaro Lagoon was sampled for steelhead, using a boat and larger beach seine containing a bag. Tidewater gobies were sampled with a shorter, fine-meshed beach seine. Nets were hauled in along the beach front and up the lagoon at 3 other locations. Water quality was measured during fish sampling. Refer to the methods section of Appendix B for more details.

iii. Index of Soon-to-Smolt Juvenile Abundance

Habitat proportions in reach segments were factored in with reach length and soon-to-smolt juvenile densities by habitat type in sampling sites. Then abundance indices were calculated for each sampled reach in each watershed. An overall watershed index of abundance was then calculated for the sampled reaches combined. Indices were compared for 2010 (a slightly above median baseflow year) and 2014 and 2015 (very dry baseflow years). Refer to the methods section of Appendix B for more details.

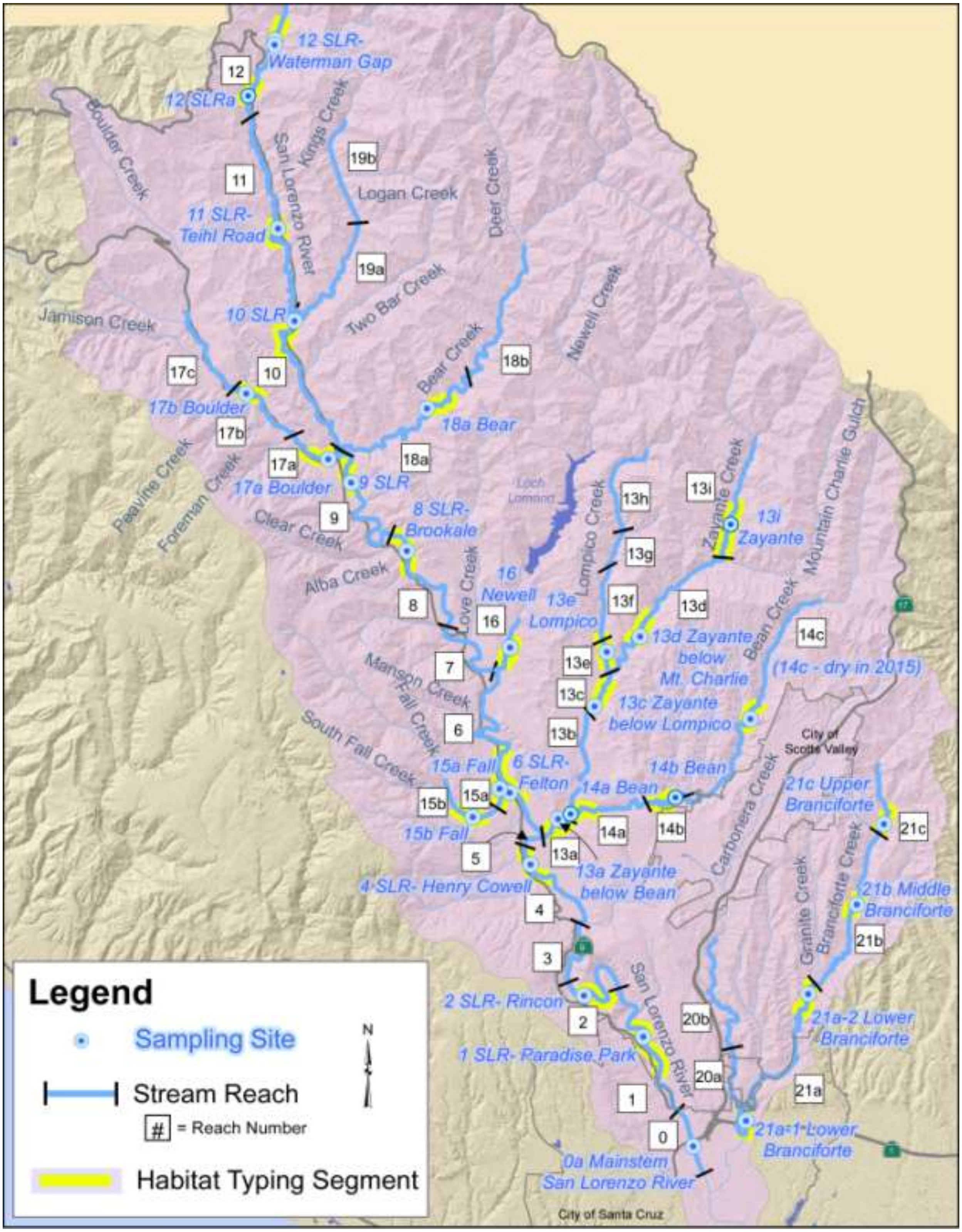

Figure A-2. San Lorenzo River Watershed– Sampling Sites and Reaches.

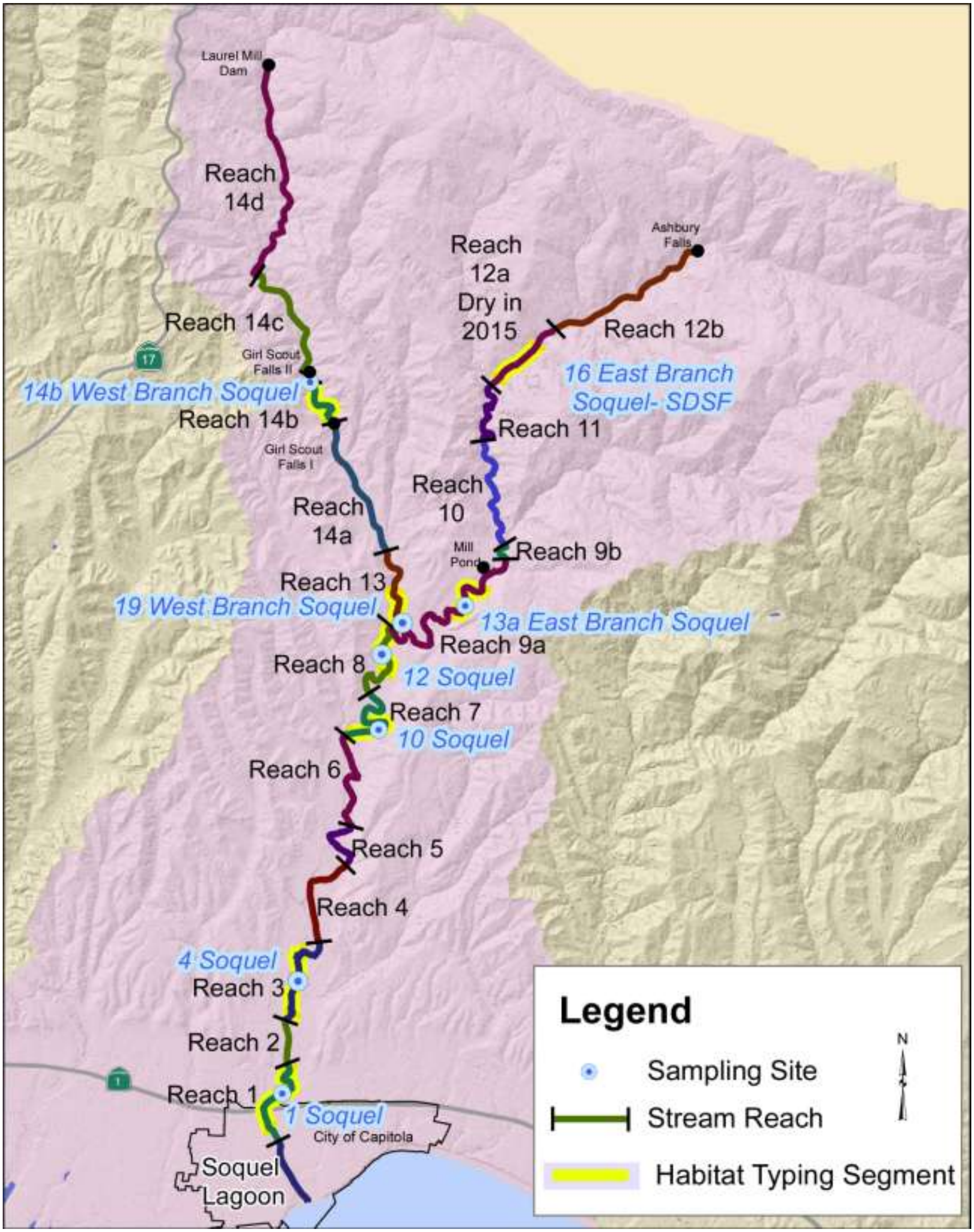

Figure A-3. Soquel Creek Watershed.

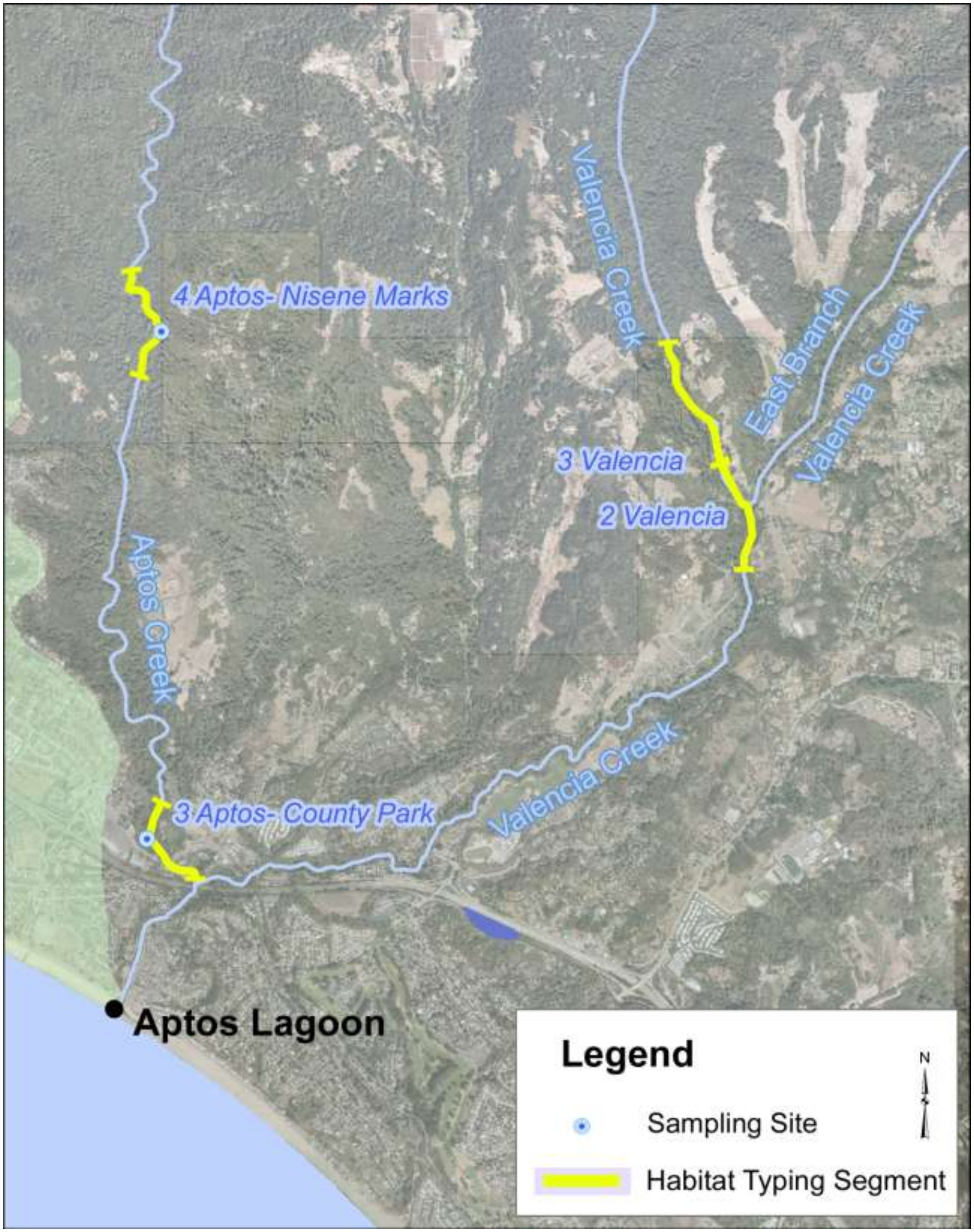

Figure A-6. Aptos Creek Watershed (Aptos Lagoon and Valencia not sampled in 2015).

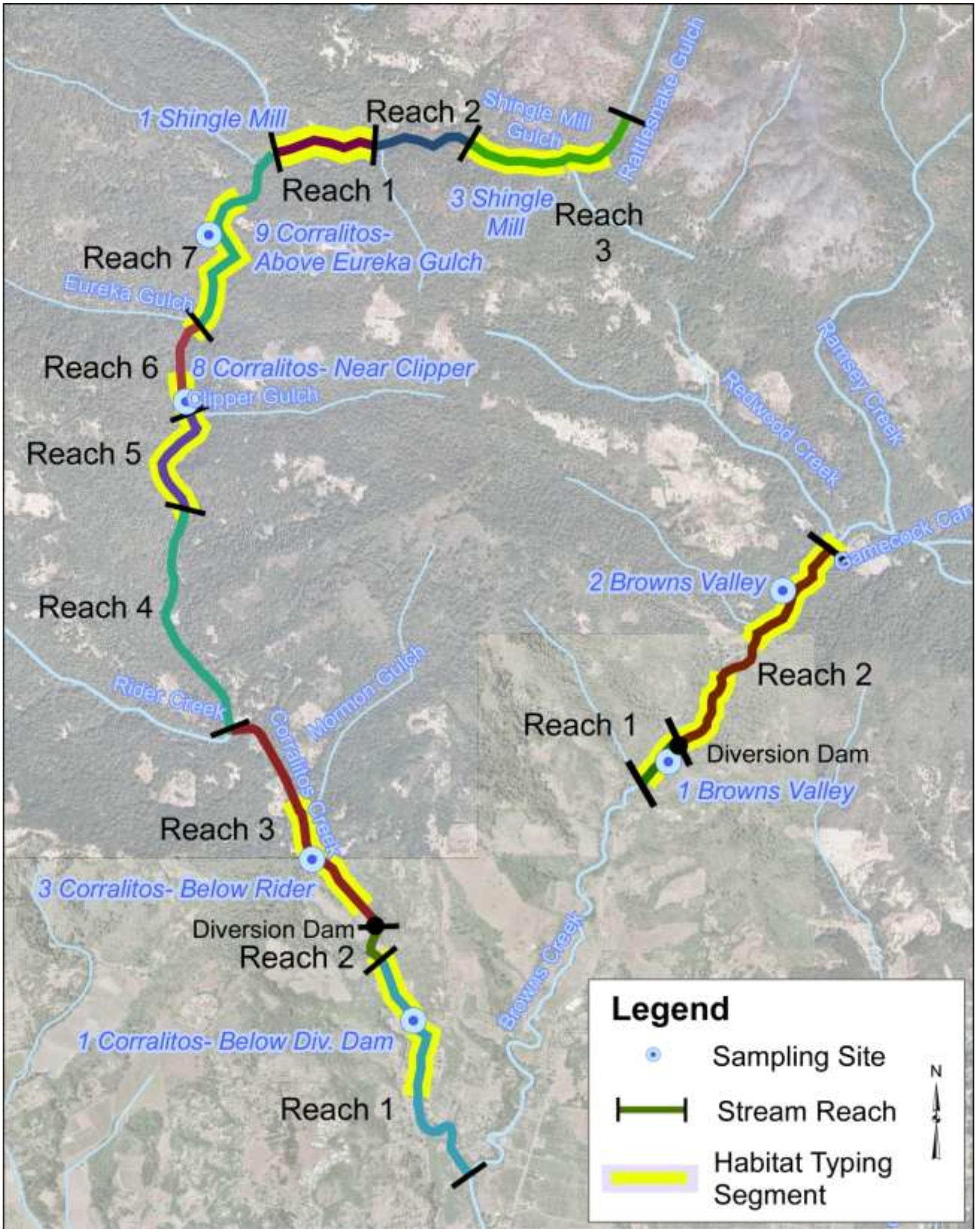

Figure A-7. Upper Corralitos Creek Sub-Watershed of the Pajaro River Watershed

D. RESULTS

Figures and tables contained in this summary report were extracted from the detailed analysis found in **Appendix B.**

i. Steelhead Abundance and Habitat Conditions in All Watersheds

1. Although we have no estimates of adult returns to the 4 watersheds that were sampled, it appears that there were insufficient adult steelhead returns after the 4 relatively small stormflows in 2015 to saturate reaches of the 4 sampled watersheds with redds or egg production.

2. WY2015 streamflows in spring-summer-fall were well below the median flow statistic, as they had been in WY2013 and WY2014. December was wet with several storms. However, the only other elevated streamflow during the winter/spring was a 5-10 day period in early February. Baseflow steadily declined from mid-April on (except for small stormflows in April, less than 20 cfs in the San Lorenzo, initially, down to less than 7 cfs in September at Big Trees Gage; less than 10 cfs initially in Soquel Creek, down to near intermittency in September at the Soquel Village Gage; less than 5 cfs initially in Corralitos Creek, down to about 1 cfs at Las Colinas Bridge in October). Streamflow comparisons between years were made for San Lorenzo and Soquel stream gages, comparing annual 5-month averages (May − September) expressed in ***Figure B-45*** *below.* 2015 had the second lowest average in 19 years, just above the 2014 average. Fall baseflow was similar in both years and lower at some sites in 2015.

3. Compared to the very dry year of 2014, rearing habitat quality in 2015 generally improved in the San Lorenzo, Aptos and Corralitos drainages and declined in the Soquel drainage. All watersheds had higher baseflow in the early dry season, which was a habitat improvement. But Soquel declined more rapidly and to a greater extent by fall. Pools and pool escape cover were generally greater in all but the Soquel drainage. Exceptions to improvement in the San Lorenzo drainage were SLR mainstem Reach 4 (compared to reach conditions in 2008), and more headwater sites in Lompico, Boulder and Branciforte creeks, as well as Newell Creek. The exception to decline in the Soquel drainage was upper mainstem Site 7. The exceptions to improvement in the Corralitos drainage were Reach 1 (below the dam and compared to 2013 reach conditions) and Reach 5/6 compared to 2012 reach conditions).

4. 2015 abundance of YOY steelhead was mostly below average at sites in 4 watersheds, though mostly higher than in 2014. It was below average in the mainstem San Lorenzo (8 of 10 sites) and in tributaries (13 of 16 sites). YOY abundance was below or near average at 6 of 8 sites in Soquel and below average in Aptos (both sites very low) and Corralitos (5 of 6 sites).

5. Indications were that low numbers of adult spawners did not saturate habitat. Indications included 1) low YOY densities in all watersheds, especially upper sites in some tributaries, except at middle

sites with near to or above average YOY densities in Soquel Creek, 2) limited windows of adequate stormflow for spawning migration, 3) relatively low adult steelhead escapement as measured on Scott Creek, 4) very low YOY densities at Aptos sites and 5) cumulative effects of repeated dry years, reducing smolt numbers, smolt size and survival when entering the ocean.

6. Despite limited adult salmonid passage opportunities during the mild 2014-2015 winter/spring, spawning access to some, but not all, upper tributary sites occurred in the San Lorenzo (Zayante 13d, Zayante 13i and Bean 14c (though it went dry), Soquel (above Girl Scout Falls I) and Corralitos (Site #9). This was evidenced by similar or higher YOY densities than downstream sites. However, some upper sites indicated limited access in the San Lorenzo (SLR 12a, Boulder 17b, Fall 15b, Newell 16, Branciforte 21b) and Soquel drainages (West Branch 21), as evidenced by low YOY densities.

7. In 2015, yearling densities were generally below average in 3 watersheds (San Lorenzo (18 of 25 sites), Aptos (both sites) and Corralitos/Browns (6 of 6 sites). This resulted from low yearling recruitment from 2014 YOY and low overwinter survival/ retention after low YOY densities in 2014.

8. In 2015, densities of Size Class II and III steelhead were generally below average in all 4 watersheds (20 of 25 sites in the San Lorenzo; all sites in Soquel, Aptos and Corralitos).

9. In 2015, soon-to-smolt abundance ratings (Size Class II and III steelhead) at many sites were shifted downward, with many rated below average because of low yearling densities and a very low proportion of YOY reaching Size Class II in usually fast-growth sites (***Tables S-1, S-2 and S-3*** *below*). In 2014, 6 sites had "very poor" ratings. In 2015 there were 13.

10. Indices of watershed abundance (production) of Size Class II and III steelhead for sampled reaches were calculated in 3 watersheds to compare annual differences. Reach lengths, habitat proportions and site densities by habitat type were incorporated. 2010 (slightly above median baseflow), 2014 (dry) and 2015 (dry) were compared. This contrast would best describe the extreme reduction in juvenile abundance in critically dry years. Abundance indices for soon-to-smolt sized steelhead in sampled stream reaches indicated a substantial decrease in 2014 and 2015 compared to 2010. From 2010 to 2014 to 2015, the San Lorenzo River index decreased from 21,000 to 7,800 to 7,500; the Soquel Creek index decreased from 3,800 to 880 to 580; the Corralitos/Browns creek index (excluding Shinglemill Gulch) decreased from 3,000 to 2,000 to 1,000. Substantial reductions resulted from low YOY densities and slow growth in high growth potential reaches of lower mainstem San Lorenzo, lower Zayante, Newell, mainstem Soquel, lower East Branch Soquel (mostly went dry) and Corralitos, as well as very low yearling densities in 2015. These typically high growth potential reaches provided much fewer YOY and yearlings in Size Class II in 2014 and 2015 compared to 2010. The Soquel Creek index was further reduced by few yearlings remaining in the East Branch when much of it went dry in 2014 and 2015.

11. As in the 4 watersheds we sampled in 2015, YOY densities were well below average at all sampling sites in Scott Creek, and the average YOY density for all sites combined was the lowest since monitoring began in 1988 (***Figure B-52 below; data from Smith 2015***). YOY densities were below average at 7 of 8 Gazos sites, but all were near average (***from Smith 2015***). The average YOY density for all sites combined in Gazos Creek in 2015 increased to 2012 levels but was still considerably less than during the 1998−2004 period (***from Smith 2015***). The average YOY density for all sites combined in Waddell Creek increased slightly in 2015 from its lowest point in 2014 (***from Smith 2015***). The overall downward trend in YOY densities (which mirrors a trend in total density) in Scott, Waddell and Gazos creeks was consistent with the overall downward trend in total juvenile densities in San Lorenzo mainstem sites and tributary sites, averaged separately.

12. In 2015, yearling densities were near or above average at 6 of 8 sites in Gazos Creek and 7 of 11 sites in Scott Creek (***from Smith 2015***). Near or above average survival of yearlings after a mild winter was in contrast to poor survival/retention of yearlings in the 4 watersheds we sampled, except for 3 of the 7 sites in the Soquel drainage. However, yearling densities in Soquel Creek were generally less than in Gazos or Scott creeks. The general downward trend in yearling densities since 1994 in Gazos to 2007 and in Scott and Waddell to 2011 has shown up and down fluctuation in Gazos since 2007 and slight increases in Scott and Waddell since 2011 (***Figure B-53 below; data from Smith 2015***).

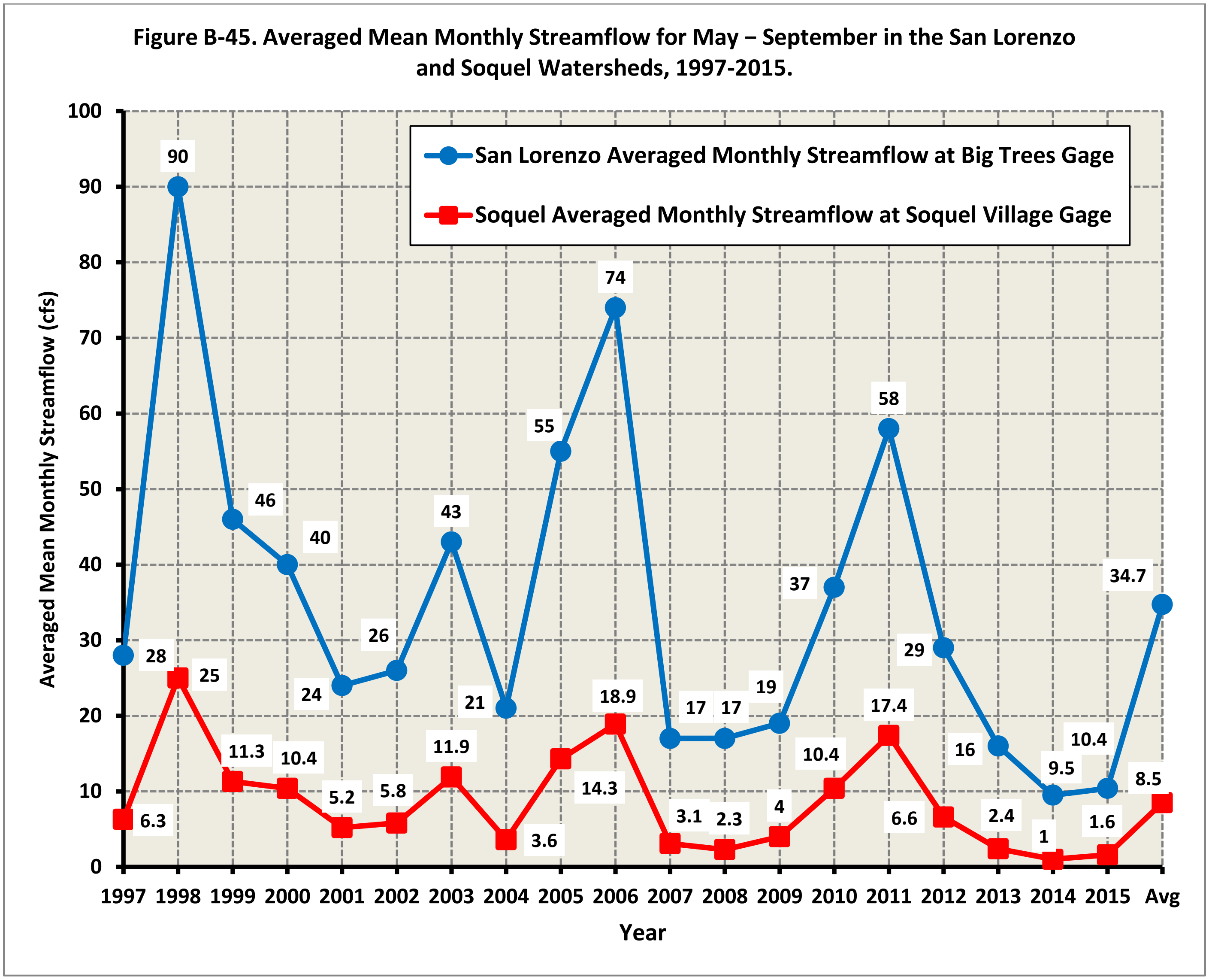

Figure B-45. Averaged Mean Monthly Streamflow for May – September in the San Lorenzo and Soquel Watersheds, 1997-2015.

Table S-1. Summary of Sampling Site Ratings in 2006–2015, based on Potential Smolt-Sized Densities.

Year	Very Poor	Poor	Below Average	Fair	Good	Very Good
2006 (n=34)	1	6	5	11	10	1
2007 (n=37)	5	2	12	12	6	0
2008 (n=36)	5 (+ 1 dry)	6	9	10	6	0
2009 (n=37)	2 (+ 1 dry)	4	11	13	6	1
2010 (n=39)	0	1	9	16	12	1
2011 (n=37)	1	2	7	18	8	1
2012 (n=38)	2 (+ 1 dry)	1	6	9	17	3
2013 (n=38)	5 (+ 1 dry)	6	10	9	7	1
2014 (n=39)	6 (+ 2 dry)	10	13	8	2	0
2015 (n=40)	13 (+ 2 dry)	7	9	9	2	0

Table S-2. Rating of Steelhead Rearing Habitat For Small, Central Coastal Streams.*
(From Smith 1982.)

1. **Very Poor**- less than 2 potential smolt-sized** fish per 100 ft of stream.
2. **Poor***** - from 2 to 4 " " "
3. **Below Average** - 4 to 8 " " "
4. **Fair** - 8 to 16 " " "
5. **Good** - 16 to 32 " " "
6. **Very Good** - 32 to 64 " " "
7. **Excellent** - 64 or more " " "

* Drainages sampled included the Pajaro, Soquel and San Lorenzo systems, as well as other smaller Santa Cruz County coastal streams. Nine drainages were sampled at over 106 sites.

** Potential smolt-sized fish were at least 3 inches (75 mm) Standard Length at fall sampling and would be large enough to smolt the following spring.

***The average standard length for potential smolt-sized fish was calculated for each site. If the average was less than 89 mm SL, then the density rating according to density alone was reduced one level. If the average was more than 102 mm SL, then the rating was increased one level.

Table S-3. 2015 Sampling Sites Rated by Potential Smolt-Sized Juvenile Density (=>75 mm SL) and Average Smolt Size, with Physical Habitat Change since 2014. (Red denotes ratings of 1−3 or negative habitat change; purple denotes ratings of 5−7. Methods for assessing habitat change in M-6 of **Appendix B**).

Site	Multi-Year Avg. Potential Smolt Density Per 100 ft	2015 Potential Smolt Density (per 100 ft)/ Avg Pot. Smolt Size SL	2015 Numeric Smolt Rating (With Size Factored In)	2015 Symbolic Rating (1 to 7)	Physical Habitat Change by Reach/Site Since 2014
Low. San Lorenzo #0a	9.0	4.8/ 83 mm	2 (Poor)	@@	Site Positive
Low. San Lorenzo #1	7.0	4.4/ 95 mm	3 (Below Avg)	@@@	Site Positive
Low. San Lorenzo #2	13.5	3.5/ 90 mm	2	@@	Reach Positive
Low. San Lorenzo #4	13.2	2.6/ 80 mm	1 (Very Poor)	@	Reach Negative
Mid. San Lorenzo #6	4.0	0.5/ 75 mm	1	@	Site Positive
Mid. San Lorenzo #8	5.6	0/ 0 mm	1	@	Site Positive
Mid. San Lorenzo #9	6.6	1.3/ 83 mm	1	@	Site Positive
Up. San Lorenzo #10	5.1	1.4/ 82 mm	1	@	Site Positive
Up. San Lorenzo #11	6.0	5.8/ 98 mm	3	@@@	Site Positive
Up.San Loren #12a (res.Rt)	8.0	6.8/ 97 mm	3	@@@	NA
Zayante #13a	9.4	2.1/ 86 mm	1	@	Site Positive
Zayante #13c	15.2	44.7/ 87 mm	5 (Good)	@@@@@	Site Positive
Zayante #13d	15.7	8.3/ 97 mm	4 (Fair)	@@@@	Site Positive
Lompico #13e	6.9	6.8/ 93 mm	3	@@@	Site Negative
Zayante #13i	7.4	7.4/ 112 mm	4	@@@@	NA
Bean #14a	4.2	1.4/ 90 mm	1	@	NA
Bean #14b	12.0	11.5/ 104 mm	5	@@@@@	Reach Positive
Bean #14c	7.8	Dry	Dry	Dry	Dry
Fall #15a	4.4	6.0/ 99 mm	3	@@@	Site Positive
Fall #15b	12.6	6.7/ 95 mm	3	@@@	Site Positive
Newell #16	13.0	2.0/ 86 mm	1	@	Site Negative
Boulder #17a	10.3	1.0/ 106 mm	2	@@	Site Positive
Boulder #17b	10.5	5.7/ 88 mm	2	@@	Site Negative
Bear #18a	9.4	1.0/ 76 mm	1	@	Site Positive
Branciforte #21b	13.1	6.8/ 103 mm	4	@@@@	Site Negative
Branciforte #21c (res. Rt)	9.8	6.2/ 115 mm	4	@@@@	Site Negative
Soquel #1	3.7	2.4/ 101 mm	2	@@	Site Negative
Soquel #4	8.3	0.9/ 79 mm	1	@	Reach Negative
Soquel #10	8.2	0.5/ 76 mm	1	@	Site Positive
Soquel #12	7.5	2.9/ 82 mm	1	@	Reach Negative
East Branch Soquel #13a	10.6	9.1/ 91 mm	4	@@@@	Site Negative
East Branch Soquel #16	9.2	Dry	Dry	Dry	Dry
West Branch Soquel #19	6.0	4.4/ 101 mm	3	@@@	Reach Negative
West Branch Soquel #21	9.6	1.6/ 92 mm	1	@	Site Negative
Aptos #3	9.2	3.5/ 112 mm	3	@@@	Site Positive
Aptos #4	8.7	1.9/ 109 mm	2	@@	Site Positive
Corralitos #1	9.1	5.0/ 85 mm	2	@@	Reach Negative
Corralitos #3	10.4	4.0/ 126 mm	4	@@@@	Site Positive
Corralitos #8	10.2	2.2/ 105 mm	3	@@@	Reach Negative
Corralitos #9	15.9	5.0/ 108 mm	4	@@@@	Site Positive
Browns #1	14.4	4.8/ 126 mm	4	@@@@	Site Positive
Browns #2	12.3	5.4/ 106 mm	4	@@@@	Site Positive

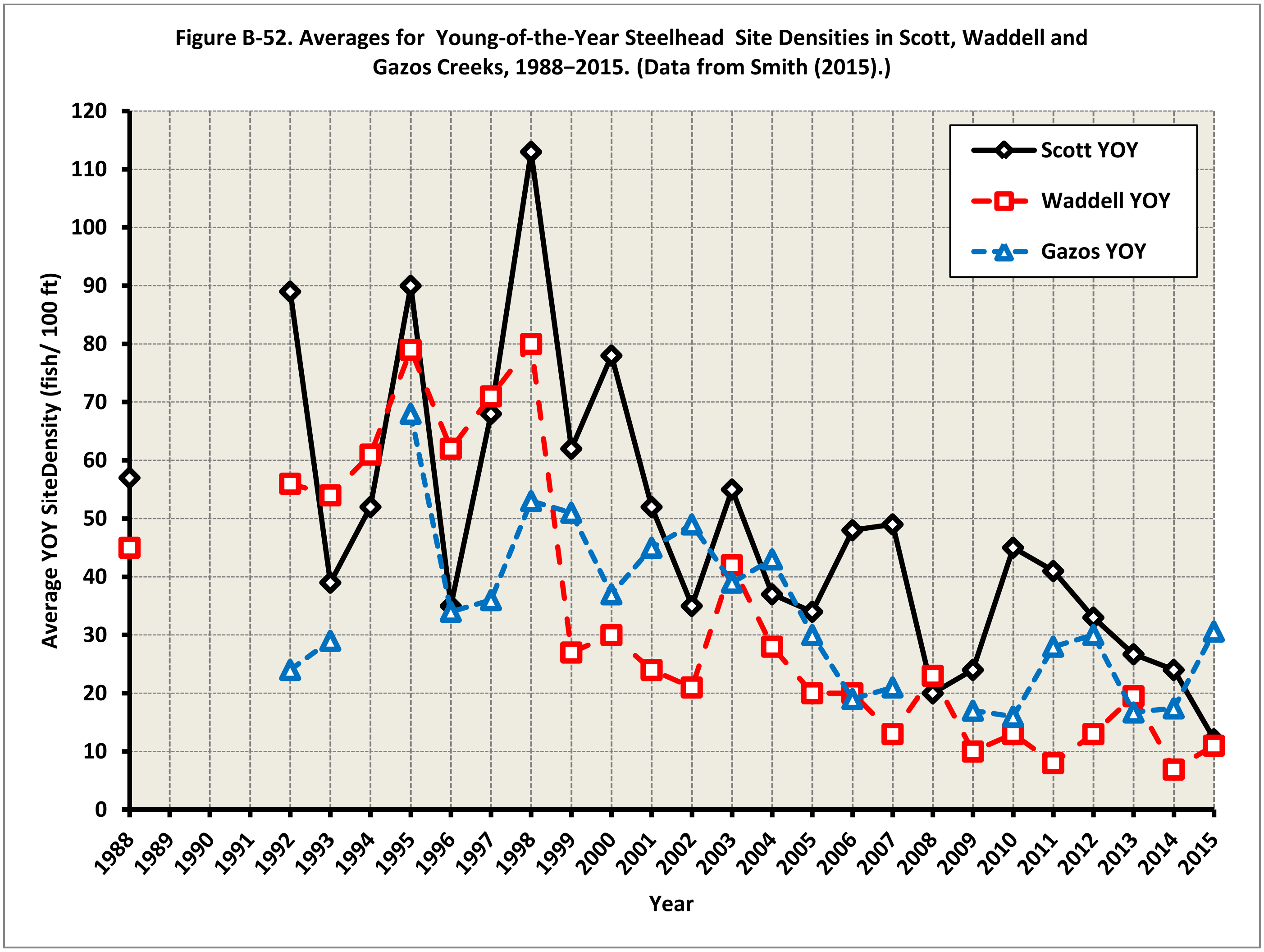

Figure B-52. Averages for Young-of-the-Year Steelhead Site Densities in Scott, Waddell and Gazos Creeks, 1988–2015.

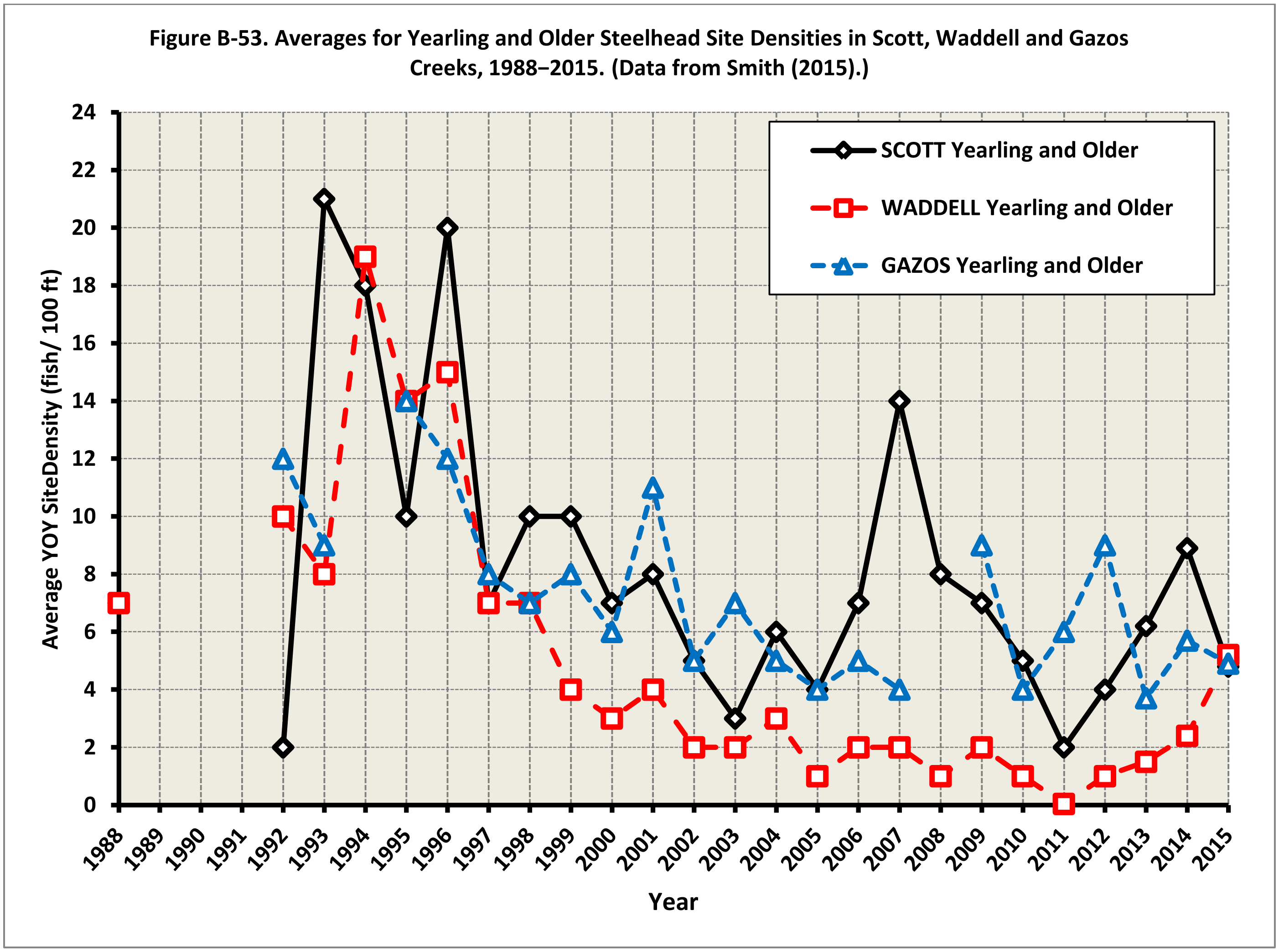

Figure B-53. Averages for Yearling and Older Steelhead Site Densities in Scott, Waddell and Gazos Creeks, 1988–2015.

ii. Steelhead Abundance and Habitat Conditions in the San Lorenzo River Watershed

1. WY2015 streamflows in spring-summer-fall were well below the median flow statistic, as they had been in WY2013 and WY2014. December was wet with several storms, the largest producing approximately 3,400 cfs at the Big Trees Gage. However, the only other elevated streamflow period during the winter/spring was a 5-10 day period in early February, producing approximately 1,400 cfs at the Big Trees Gage. Baseflow steadily declined from mid-April on (except for small stormflows in April), from less than 20 cfs in the San Lorenzo, initially, down to less than 7 cfs in September at Big Trees Gage (***Figures B-36a-b*** *below*).

2. ***In the lower and middle mainstem in 2015***, rearing habitat quality improved at all replicated sampling sites and habitat-typed Reach 2, primarily due to increased baseflow (more food)

early in the dry season (**Figure B-45** *above*) and more escape cover (***Table S-3*** *above;* **Table B-13b** *below*). Reach 4 had lower habitat quality compared to 2008, another dry year, with lower baseflow, shallower conditions and less escape cover. With statistically significant increases in YOY density from 2014 to 2015, a lower proportion of them reached Size Class II by fall 2015 (***Figure B-17b*** *below*). Steelhead captured at Sites 0, 1 and 2 were scanned for PIT tags. None were detected, as in previous years.

3. ***Upper mainstem and tributary steelhead sites/reaches*** in 2015 had mostly improved habitat quality (10 of 14 sites/reaches) primarily due to increased baseflow (more food) early in the dry season and more pool escape cover. Habitat declined in upper tributary sites, including Lompico, Boulder 17b and Branciforte 21b, as well as Newell 16, with less baseflow, reduced pool depth and similar/less escape cover (***Table S-3*** *above;* ***Table B-13b*** *below*). Upper Bean 14c was dry.

4. ***YOY densities in the mainstem sites*** were below average and lower at 8 of 10 sites but higher than in 2014 at all 10 sites (***Table 18 in Appendix B; Figures B-2a-b*** *below*). The density increase at mainstem sites was statistically significant (***Table 45 in Appendix B***). YOY recruitment into the mainstem from tributaries has apparently been minimal from 1999 onward, except for possibly at Site 4 in 2008 from lower Zayante Creek. ***Total densities*** mirrored YOY densities at mainstem sites (***Figure B-1*** *below*). Increased total densities at mainstem sites were statistically significant.

5. ***YOY densities in tributary sites*** were below average at 10 of 14 sites and increased at 6 of 11 wetted sites compared to 2014 (***Table 23 in Appendix B; Figures B-2a-b*** *below*). The highest YOY density by far was found at middle Zayante 13c, as was the case in 2013, with good cover provided by overhanging willow and dogwood. All tributary sites were dominated by very small YOY in 2015, with good yearling retention only at SLR-11, SLR 12a and Bean 14b. As in 2014, very few YOY reached soon-to-smolt-size in 2015 in tributaries due to low baseflow and associated restricted insect drift. ***Total densities*** mirrored YOY densities at tributary sites (***Figure B-1*** *below*).

6. The trend in total densities rebounded modestly in mainstem and tributary sites in 2015 after a low point was reached in 2014 (***Figures B-21 and B-23*** *below*).

7. ***Yearling densities*** were relatively low in the mainstem and tributaries (below average at 8 of 10 mainstem and 12 of 15 tributary steelhead sites) and mostly similar or less than in 2014 (***Figure B-3*** *below;* ***Tables 19 and 24 in Appendix B***). Sites that retained above average densities of yearlings were SLR 11 and Bean 14b.

8. ***Densities of important larger Size Class II and III steelhead*** (=>75 mm SL; soon-to-smolt) ***at mainstem sites*** in 2015 were below average at all 9 sites and lower than in 2014 at 4 of 9 sites (***Table 21 in Appendix B***; ***Figure B-4*** *below*). Relatively low densities of soon-to-smolt fish in

typically high growth reaches of the lower River were due to much below average densities of YOY in a low adult spawning year with poor spawning success and slow YOY growth. ***In tributaries***, Size Class II and III densities were below average and less than in 2014 at 9 of 14 sites (***Table 25 in Appendix B; Figure B-4*** *below*). The trend in Size Class II and III densities went up slightly in the mainstem and more so in tributaries (due to the abundance at Zayante 13c) (***Figures B-22 and B-24a*** *below*). When annual average site densities of soon-to-smolt sized steelhead were plotted with 5-month baseflow averages (May through September), they increased in some wet years because more YOY reached Size Class II and declined in some dry years because fewer YOY reached Size Class II (***Figures B-24b and B-24c*** *below*). There was also more habitat for yearlings in wetter years, and yearlings also contributed to the larger size class at some upper tributary sites.

9. In the fourth year of a severe drought, only 3 steelhead sites were rated "fair" (Zayante 13d, Zayante 13i and Branciforte 21b) and 2 sites were rated "good" (Zayante 13c and Bean 14b) (***Table S-3*** *above*), based on soon-to-smolt densities. The remainder were rated between "very poor" (mostly) and "below average."

10. ***The abundance index for soon-to-smolt sized steelhead*** in sampled reaches decreased from 2010 (21,000) to 2014 (7,800) to 2015 (7,500). The nearly two-thirds reduction in dry years resulted primarily from 1) very low YOY densities in 2014 and 2015 in high growth potential reaches, 2) slow growth in high growth potential reaches in 2015 (lower mainstem San Lorenzo, lower/middle Zayante and Newell) (***Figures B-17a and B-2a-b*** *below*), and 3) the low yearling densities at most sites in 2014 and 2015 (***Figure B-33*** *below*). These factors lead to below average Size Class II and III densities at most sites in 2014 and 2015 (***Figure B-4*** *below*).

11. Riffle habitat conditions have worsened in Reach 2 between 1999 and 2015 primarily due to shallower conditions with much less escape cover (***Figures B-54 and B-55*** *below*).

12. The trend in pool depth in upper Zayante Reach 13d (***Figure B-56*** *below*) mirrored fluctuation in baseflow (***Figure B-45*** *above*). Depths were greatest during wetter years of 1998, 1999, 2005, 2006, 2010 and 2011. Escape cover indices have fluctuated since 1998 (***Figure B-57*** *below*), with somewhat higher ones in some wetter years (1998−2000, 2003, 2005 and 2011) (**Figure 45**). However, there was an abrupt decline in 2006, despite high baseflow, and there was an abrupt improvement in 2009 despite low baseflow. The low point was in 2014 during the recent drought, but a sizeable improvement occurred in 2015. This resulted from more instream wood and rootmasses in the segment in 2015.

Table B-13b. Habitat Change in the SAN LORENZO MAINSTEM AND TRIBUTARIES from 2014 to 2015, Based on Reach Data Where Available and Site Data, Otherwise.

Reach Comparison or (Site Only)	Baseflow Avg. May-September (Important Parameter)	Pool Depth / Fastwater Depth in Main-stem below Boulder Cr.	Fine Sediment Pool/ Fastwater	Embed-dedness Pool/ Fastwater	Pool Escape Cover/ Fastwater Habitat Cover in Mainstem below Boulder Cr.	Overall Habitat Change
(Mainstem 0a)	+	− / +	NA	Similar	+/+	+
(Mainstem 1)	+ Similar	/ −	/ Similar	/ + Runs	/ +	+
Mainstem 2	+ Similar	− / −	Similar	+ / Similar	+ pools / + riffles; − runs	+
Mainstem 4	− (since 2008)	− / − Similar (since 2008)	+ (since 2008)	Similar (since 2008)	− / − (since 2008)	−
(Mainstem 6)	+ Similar	/ +	Similar	/ +	/ +	+
(Mainstem 8)	+ Similar	/ + Similar	/ −	/ − runs	/ +	+
(Mainstem 9)	+ Similar	/ − riffles + runs	/ Similar	/ + runs	/ +	+
(Mainstem 10)	+ Similar	− / + run	Similar/ - run	+/ − runs	+	+
(Mainstem Near Teihl Rd 11)	+ Similar	− / Similar	Similar	+ (pool and run)	+	+
(Zayante 13a)	+	−/−	+ (pool)/ Similar	+ (run)	+	+ (Cover)
(Zayante 13c)	+ Similar	+ / Similar	Similar/ Similar	− (pool) + fastwater)	+	+ (Cover)
Zayante 13d	+ Similar	+ / +	− (pool)/ Similar	Similar	+	+ (Cover)
(Lompico 13e)	+ then − Late	− / +	Similar/ −	Similar/ +	Similar	−
Bean 14b	+ Similar	+/ Similar	+ /+	+ / +	Similar	+
(Fall 15a)	Similar	+ / +	Similar/ Similar	+ / +	Similar	+
(Fall 15b)	+ Similar	−/+	− / −	+ / +	Similar	+
(Newell 16)	− Similar	−/+	NA	− /− run + riffle	similar	−
(Boulder 17a)	+ Similar	+ / Similar	+ / −	+/ Similar	+	+
(Boulder 17b)	+ then very − late	−/ +	−/ Similar	Similar	−	−
(Bear 18a)	+ Similar	+/Similar	+/Similar	Similar/ − riffle	+	+
(Branciforte 21b)	+ then very − late	− / −	+ / −	+ / + run	−	−
(Branciforte 21c)	+ then very − late	− / −	−/ Similar	Similar/ Similar	Similar	−

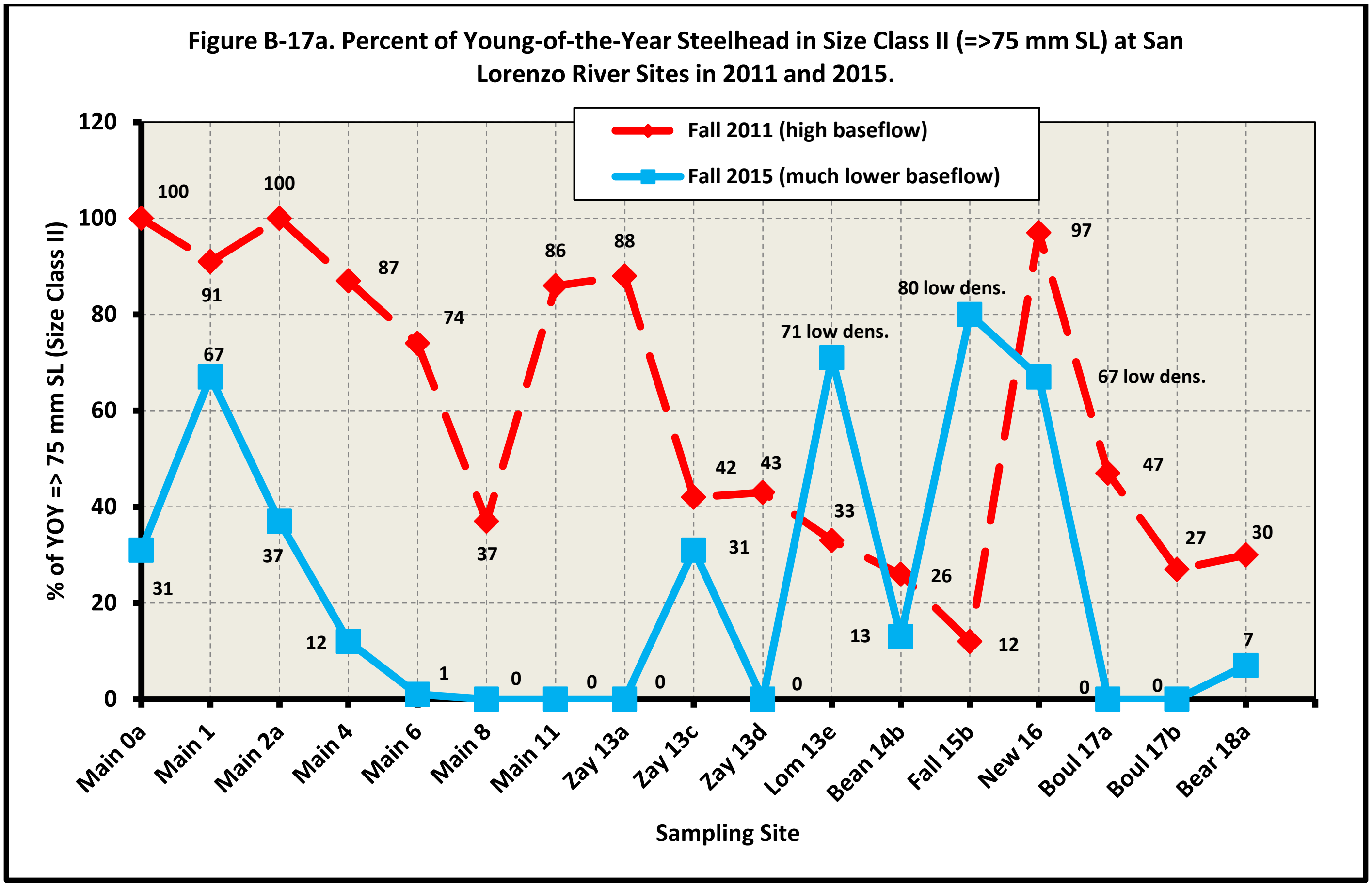

Figure B-17a. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at San Lorenzo River Sites in 2011 and 2015.

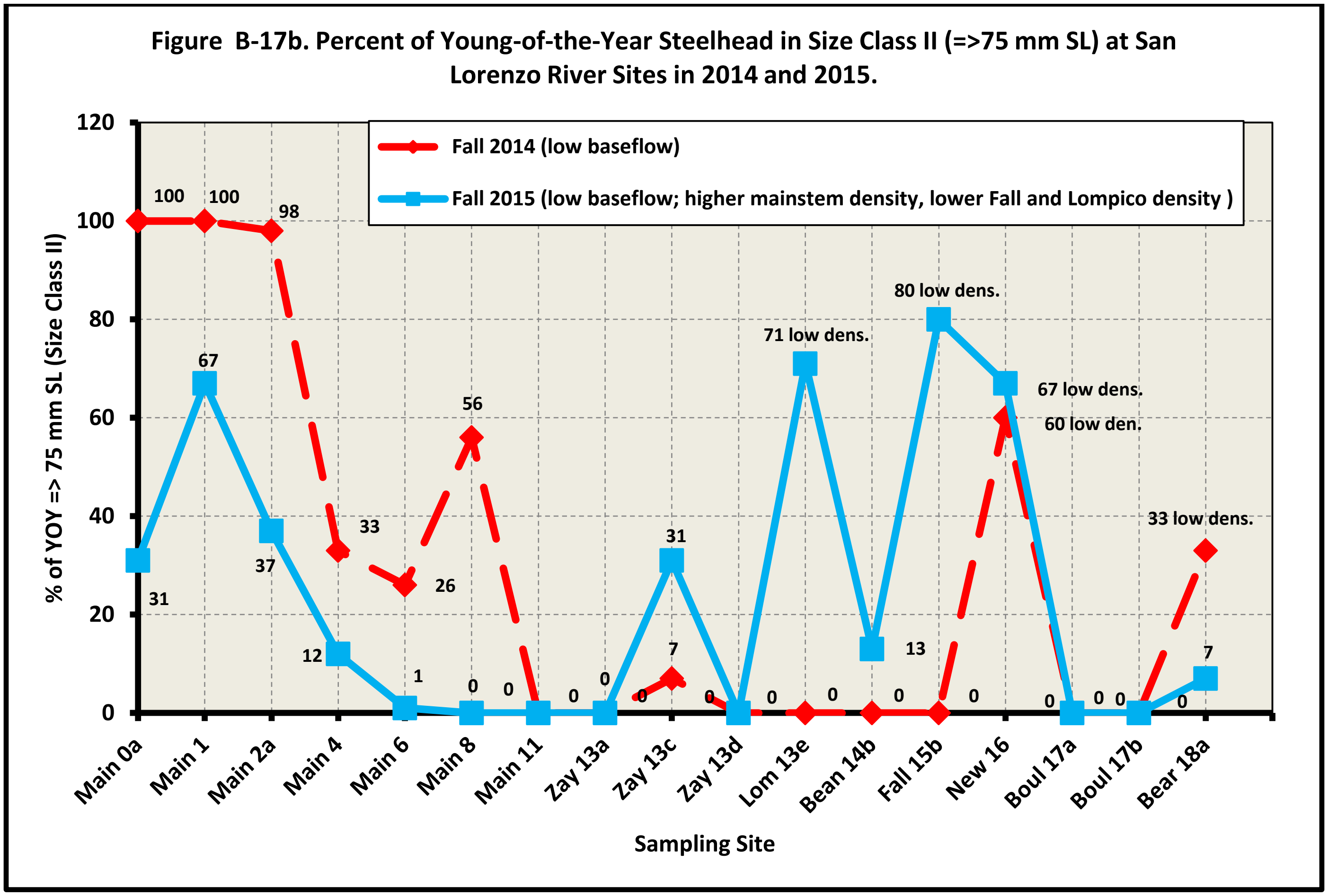

Figure B-17b. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at San Lorenzo River Sites in 2014 and 2015.

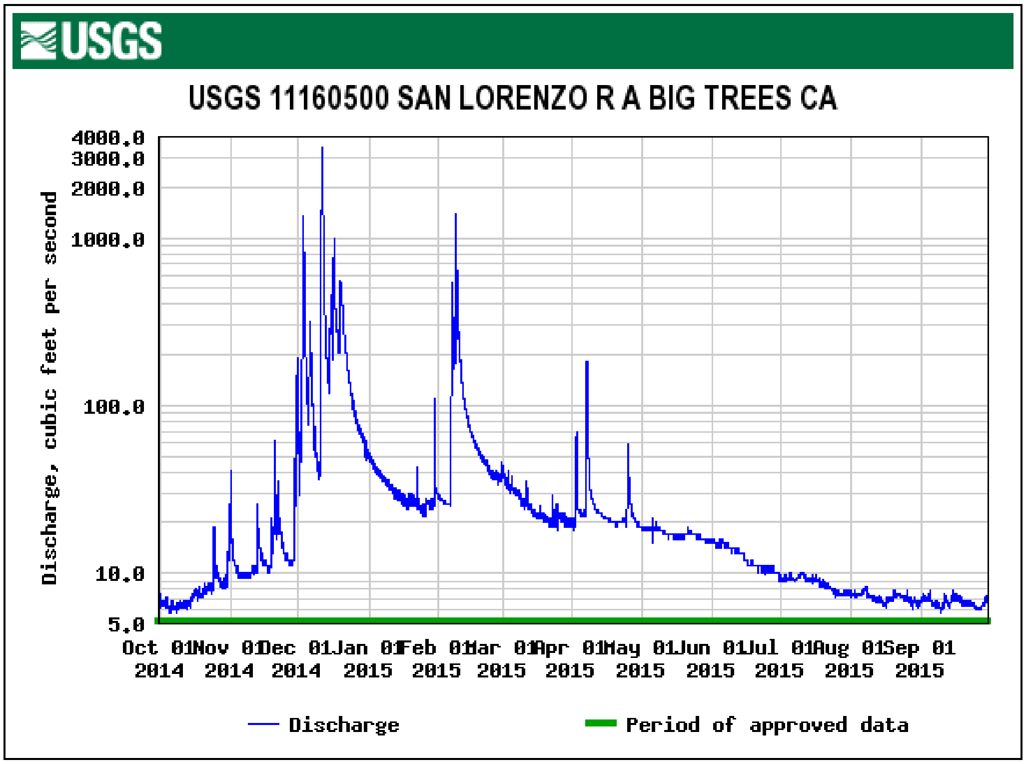

Figure B-36a. The 2015 Discharge for the USGS Gage On the San Lorenzo River at Big Trees.

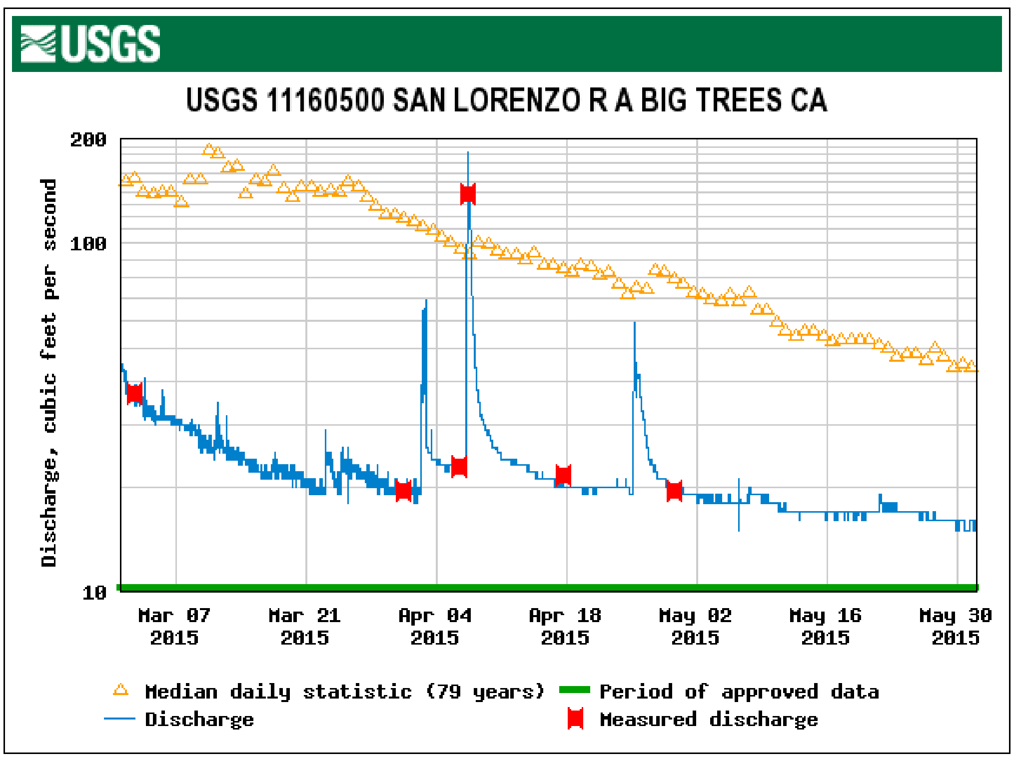

Figure B-38b. The March−May 2015 Discharge of Record for the USGS Gage On the San Lorenzo River at Big Trees.

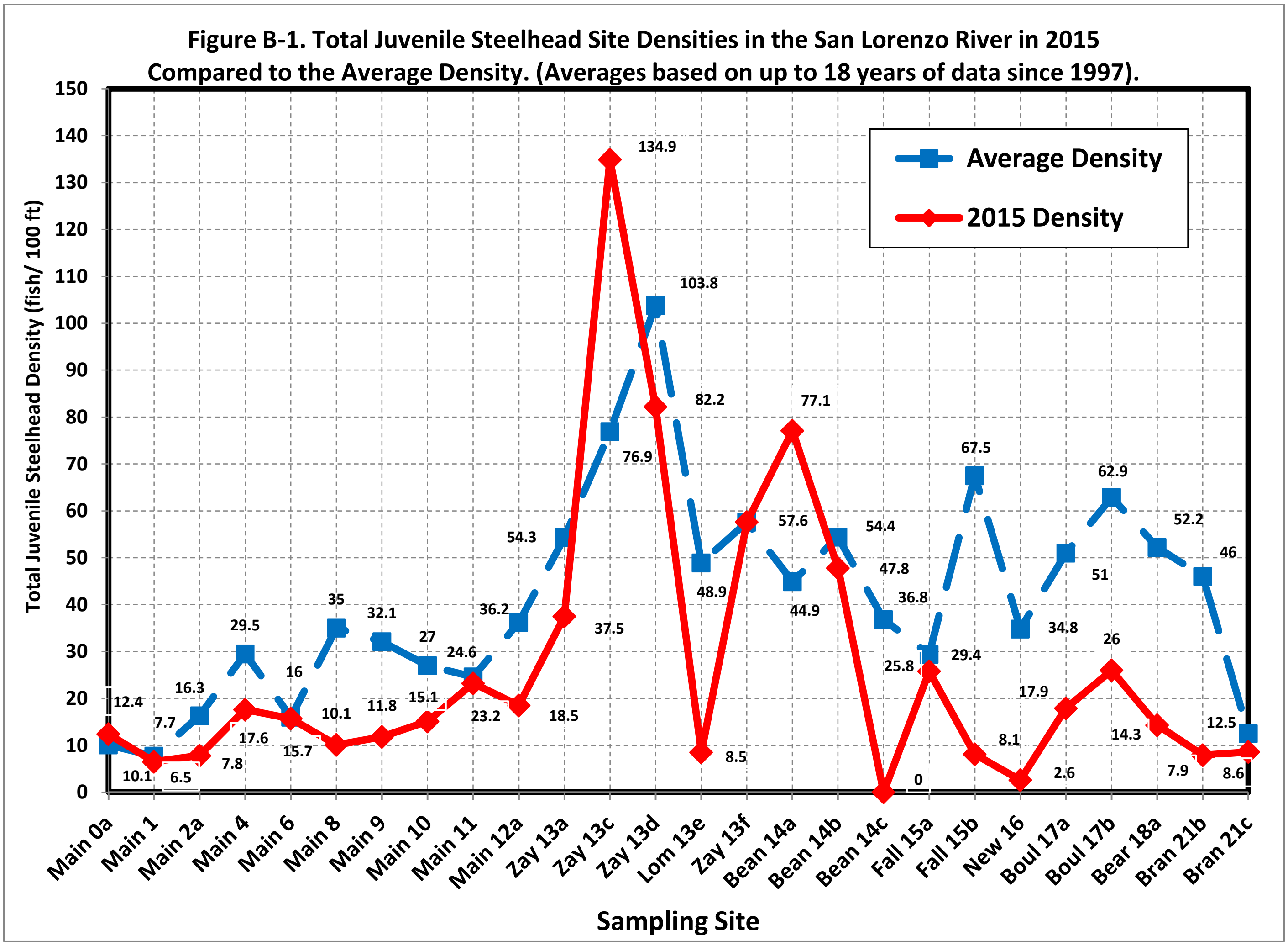

Figure B-1. Total Juvenile Steelhead Site Densities in the San Lorenzo River in 2018 Compared to the Average Density. (Averages based on up to 18 years of data since 1997).

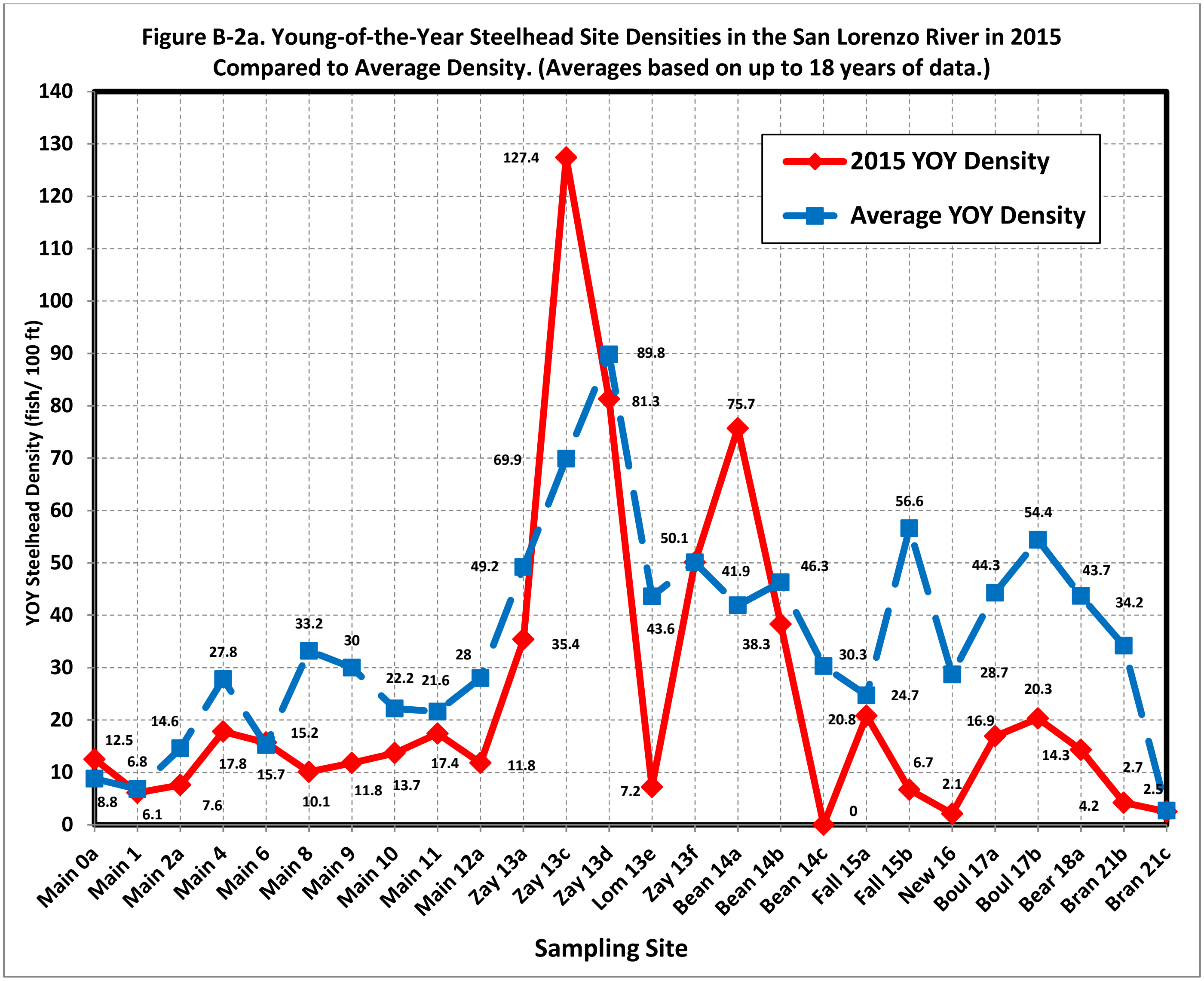

Figure B-2a. Young-of-the-Year Steelhead Site Densities in the San Lorenzo River in 2015 Compared to Average Density. (Averages based on up to 18 years of data.)

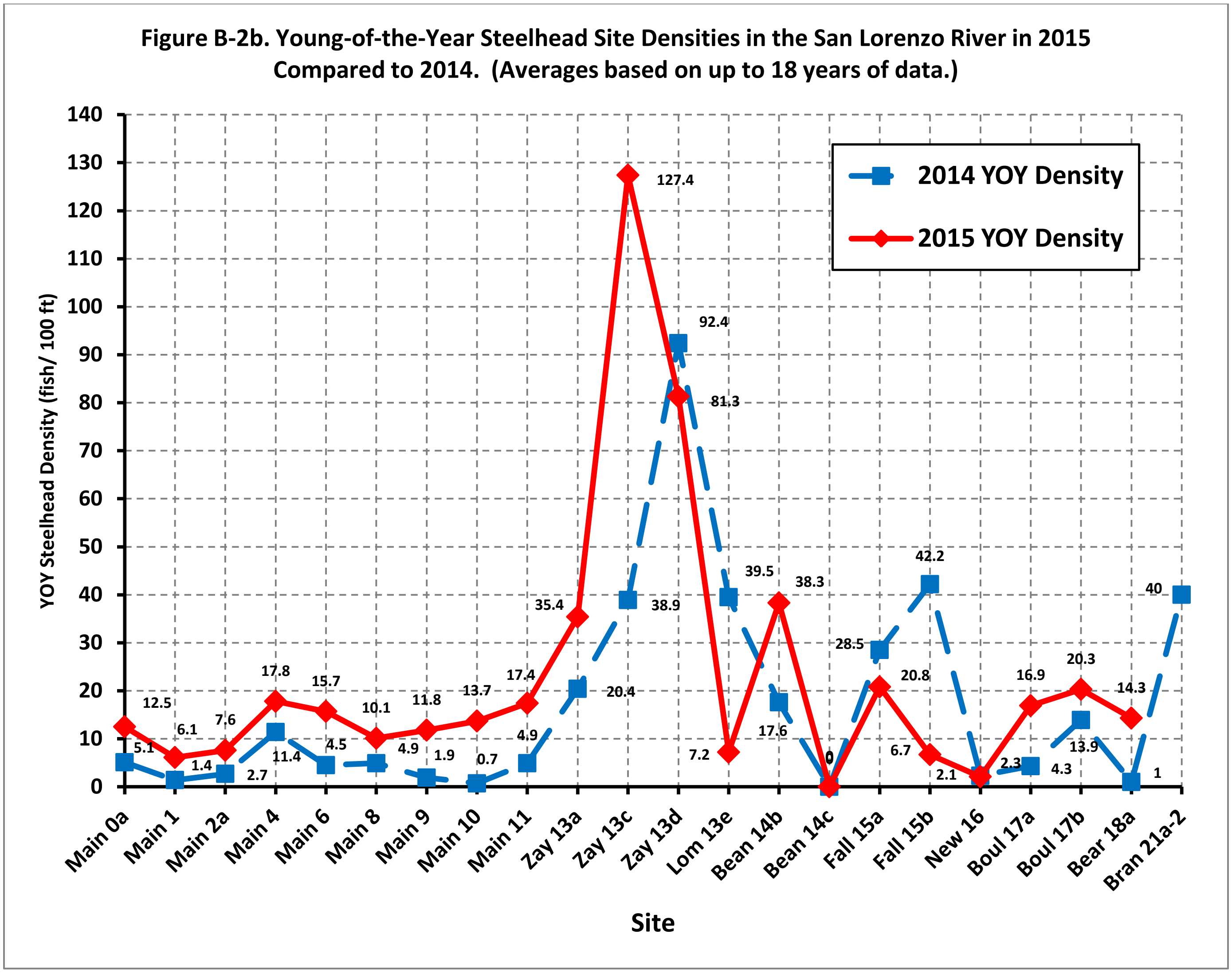

Figure B-2b. Young-of-the-Year Steelhead Site Densities in the San Lorenzo River in 2015 Compared 2014.

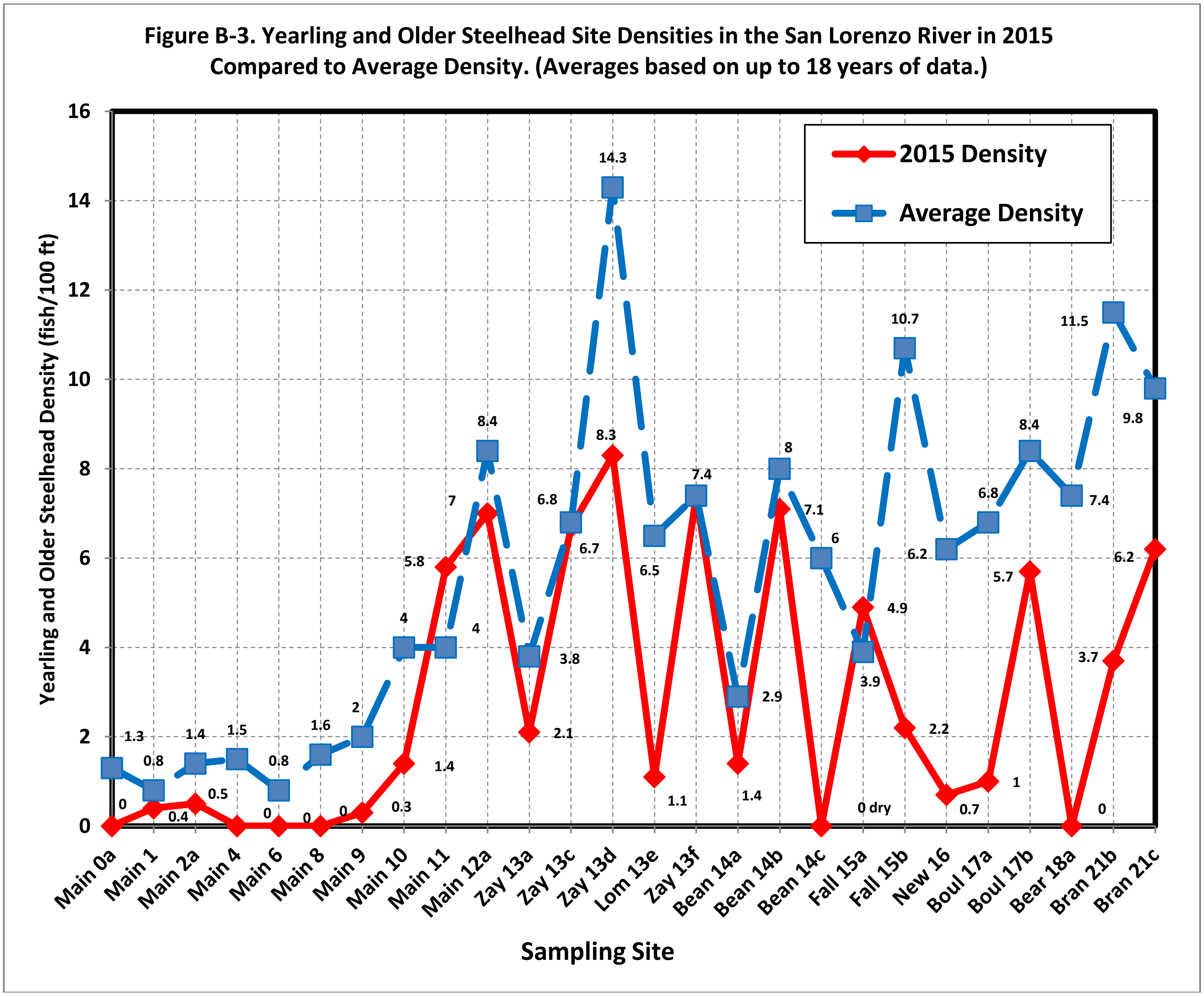

Figure B-3. Yearling and Older Steelhead Site Densities in the San Lorenzo River in 2015 Compared to Average Density. (Averages based on up to 18 years of data.)

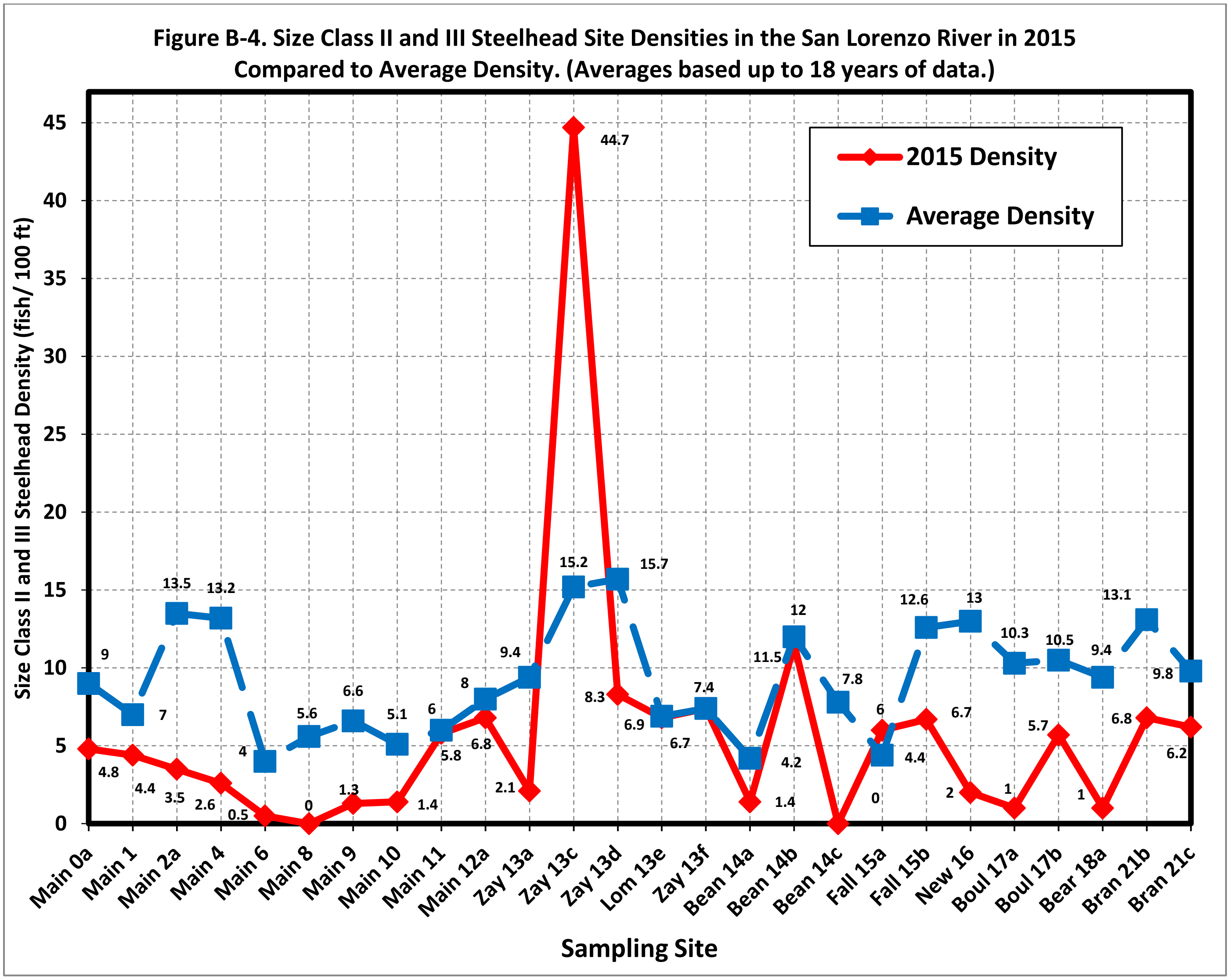

Figure B-4. Size Class II and III Steelhead Site Densities in the San Lorenzo River in 2015 Compared to Average Density. (Averages based on up to 18 years of data.)

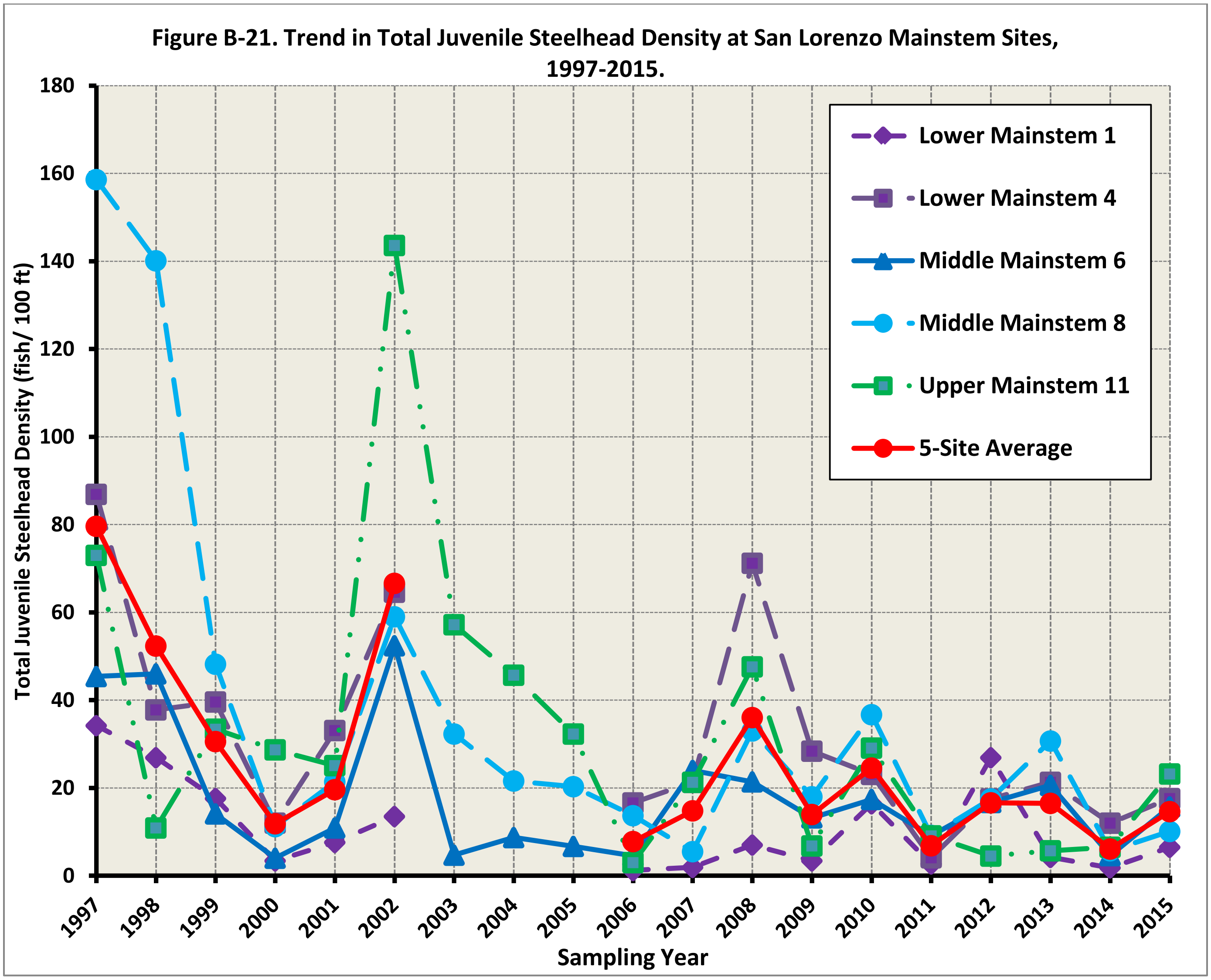

Figure B-21. Trend in Total Juvenile Steelhead Density at San Lorenzo Mainstem Sites, 1997-2015.

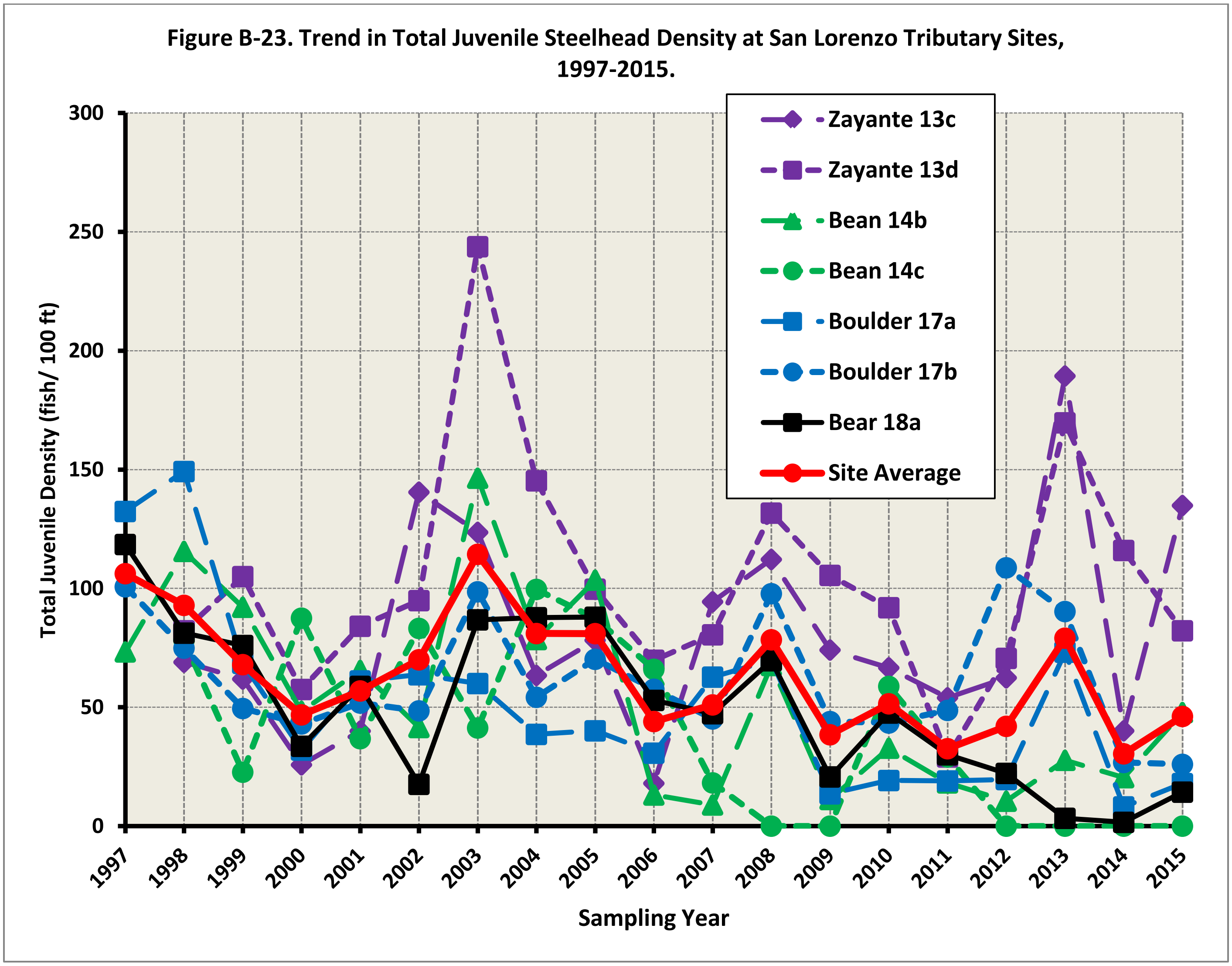

Figure B-23. Trend in Total Juvenile Steelhead Density at San Lorenzo Tributary Sites, 1997-2015.

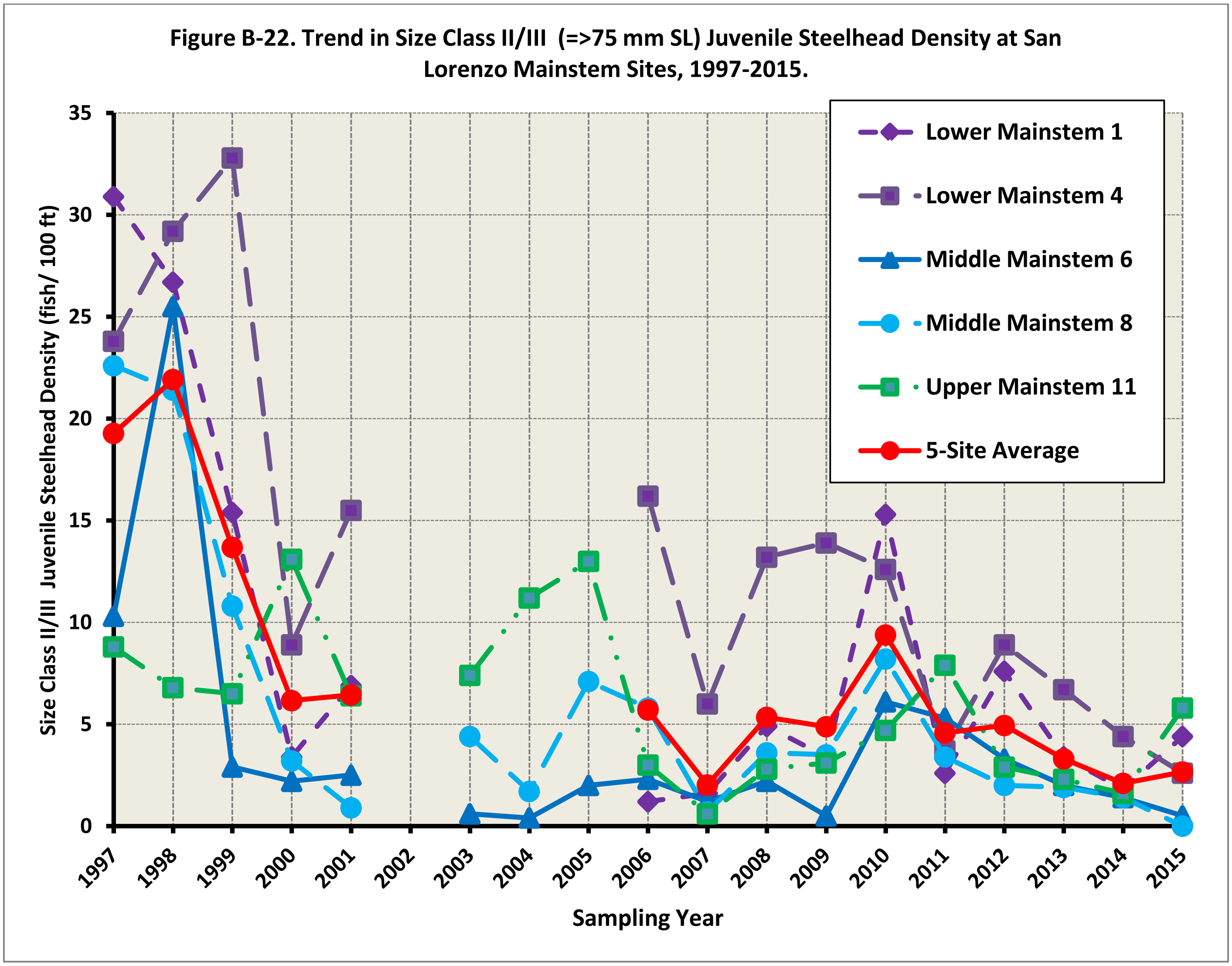

Figure B-22. Trend in Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at San Lorenzo Mainstem Sites, 1997-2015.

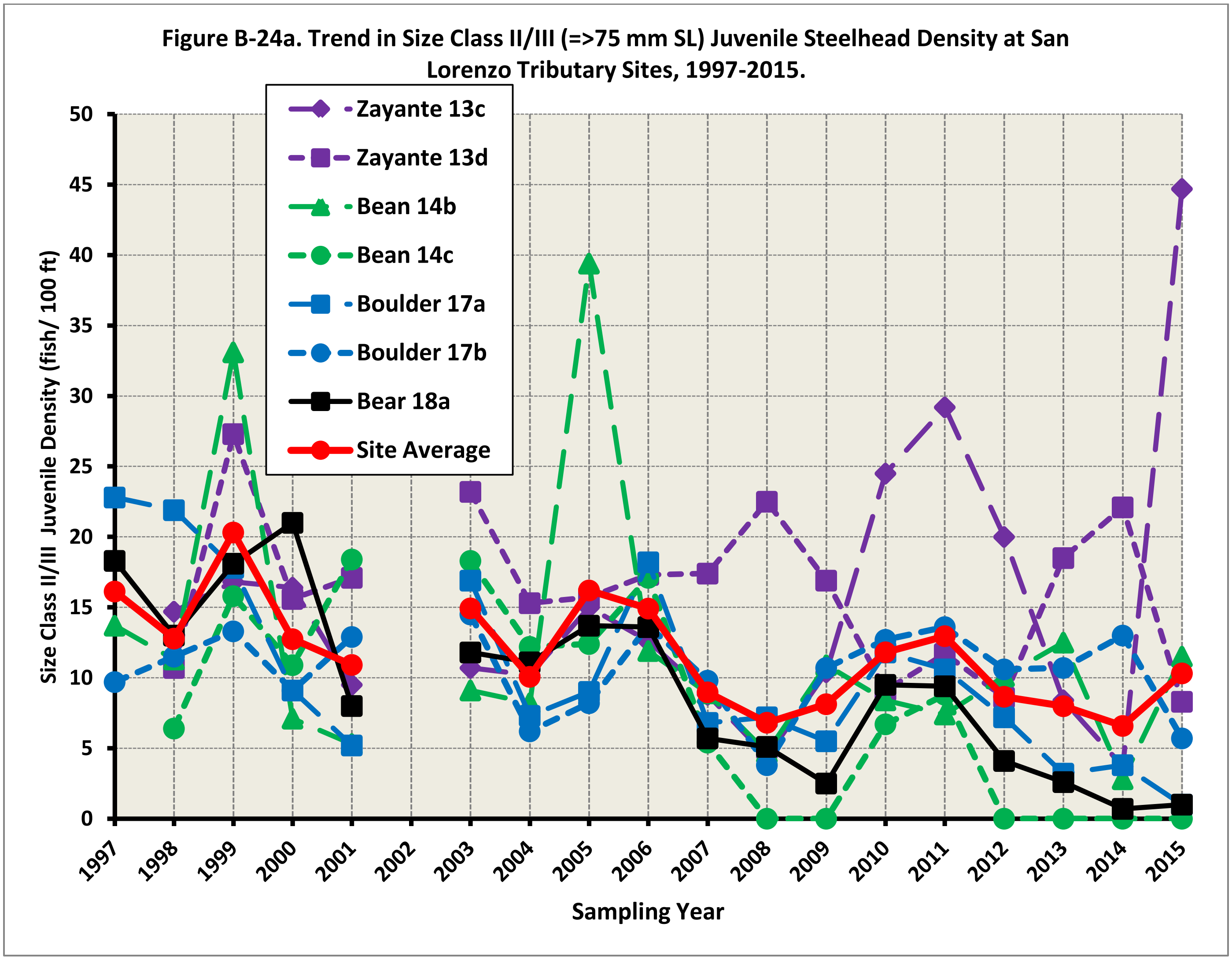

Figure B-24a. Trend in Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at San Lorenzo Tributary Sites, 1997-2015.

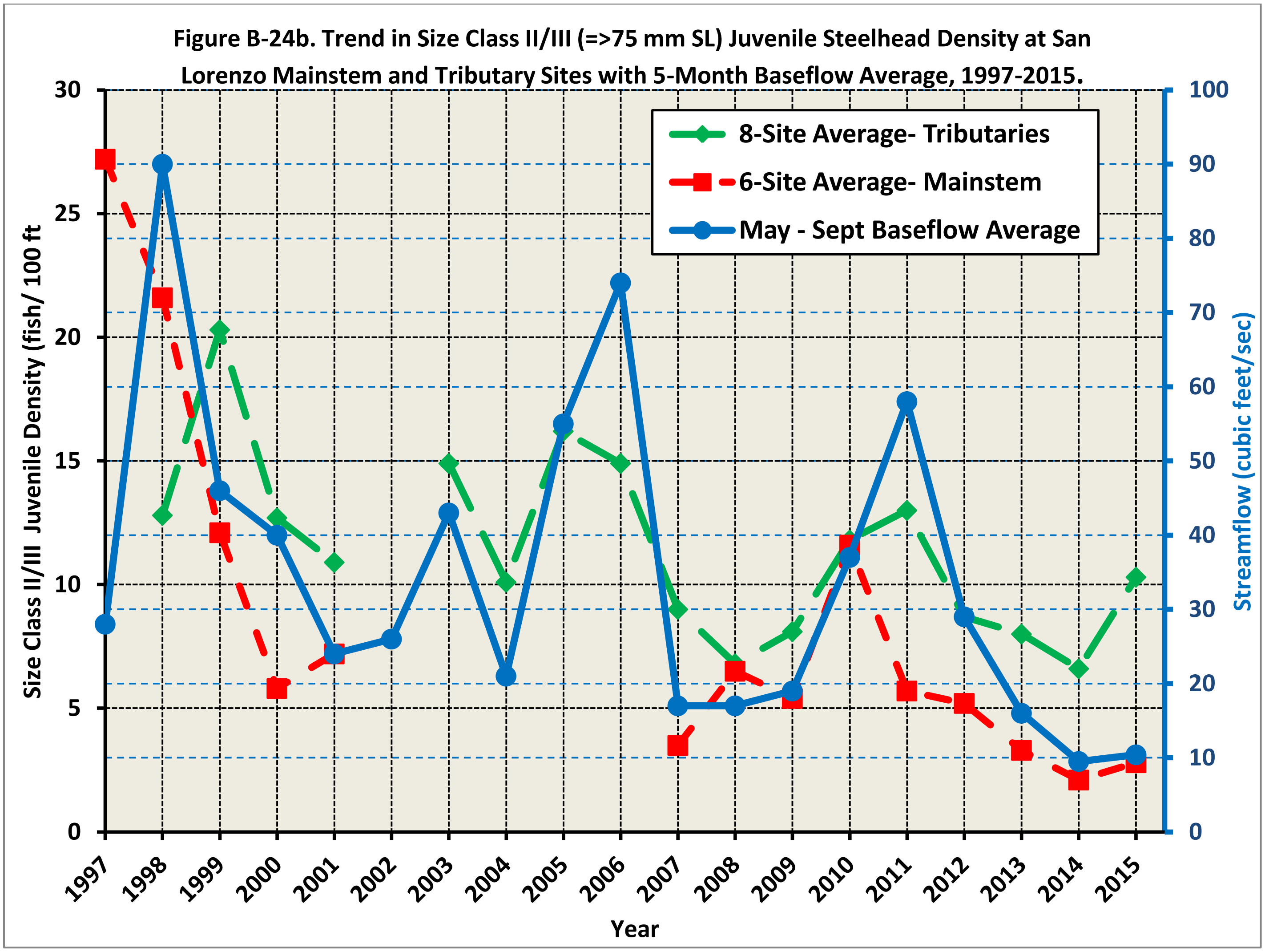

Figure B-24b. Trend in Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at San Lorenzo Mainstem and Tributary Sites with 5-Month Baseflow Average, 1997-2015.

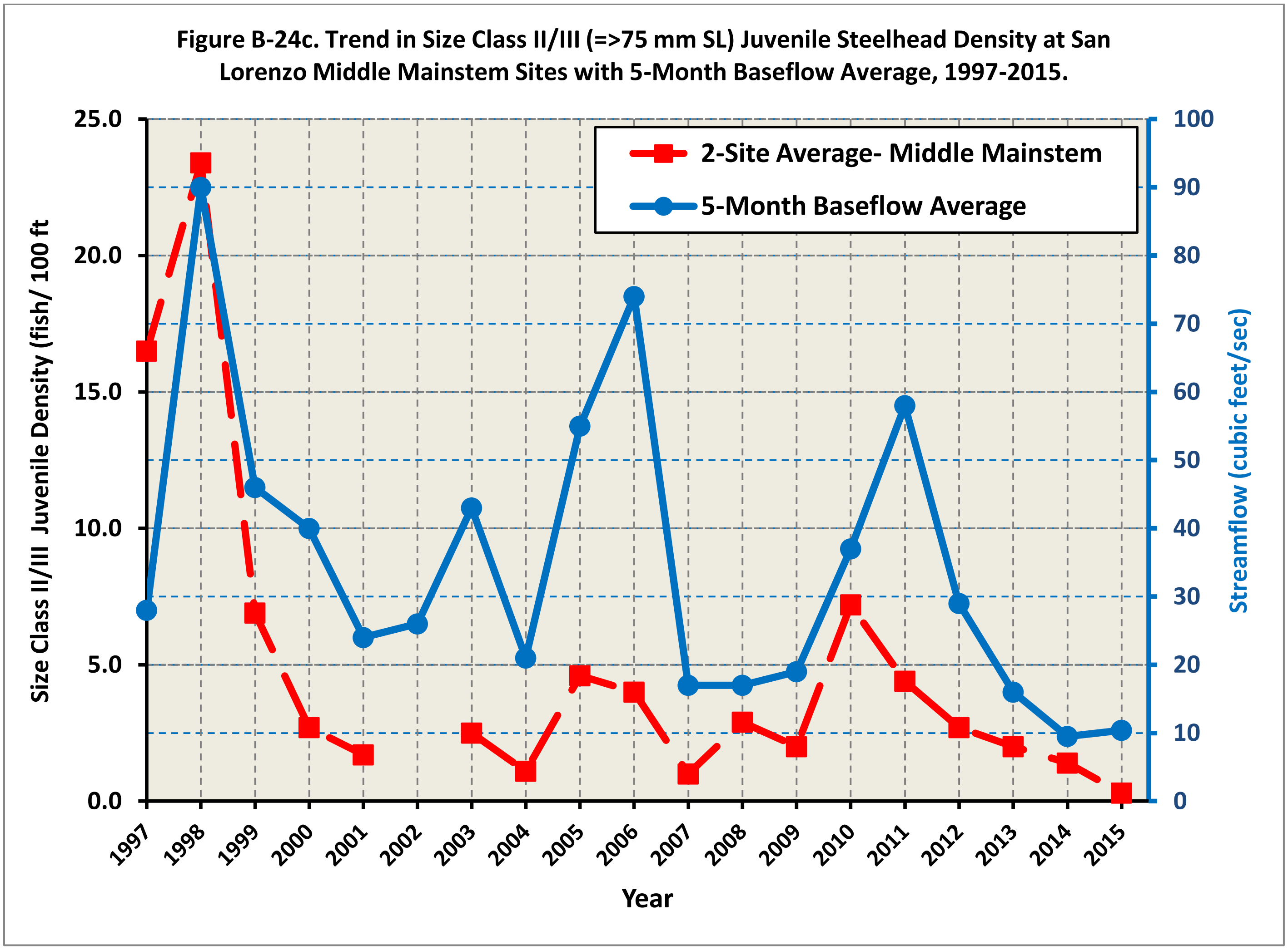

Figure B-24c. Trend in Average Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at San Lorenzo Middle Mainstem Sites with 5-Month Baseflow Average, 1997-2015.

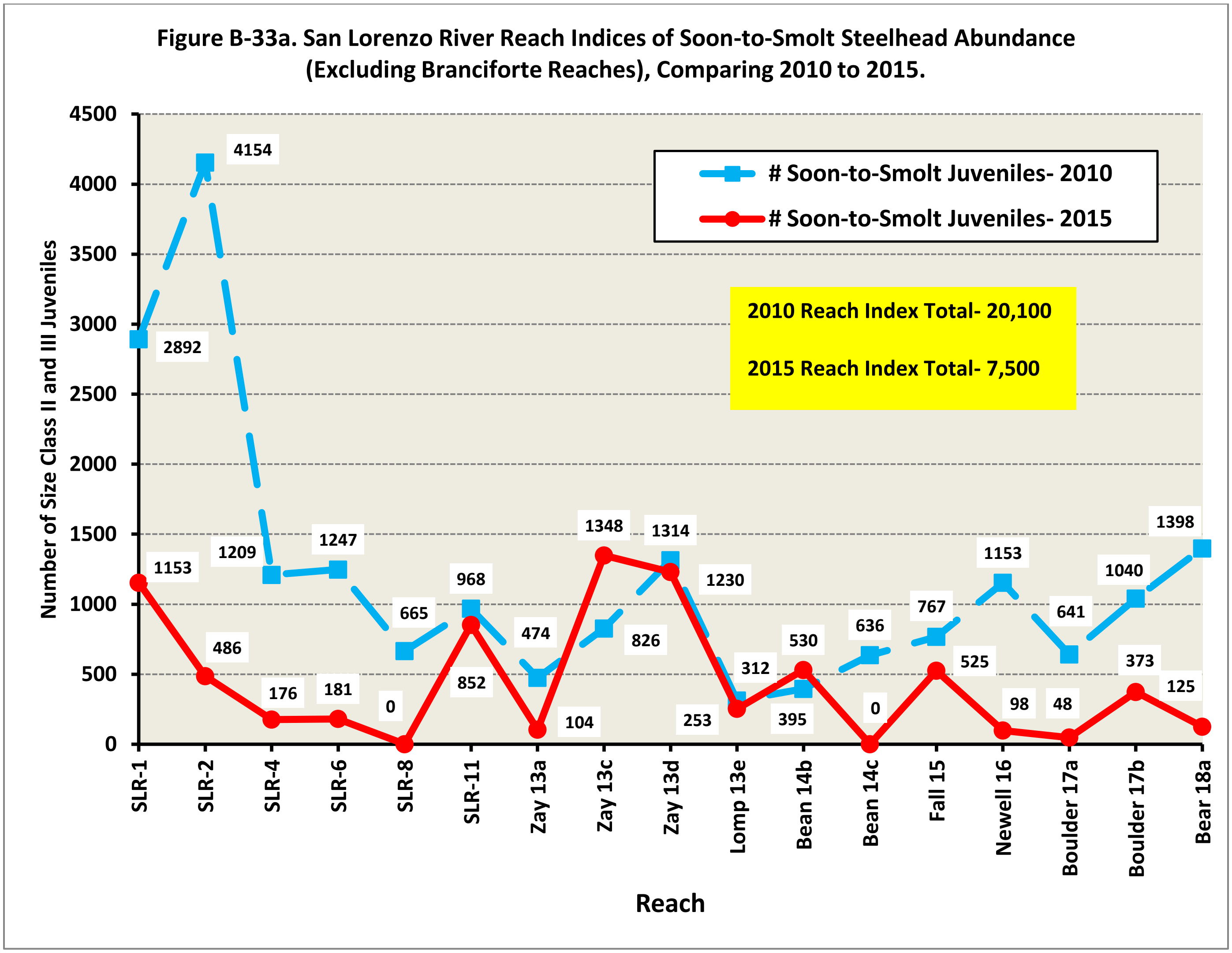

Figure B-33a. San Lorenzo River Reach Indices of Soon-to-Smolt Steelhead Abundance, comparing 2010 (Wetter Year) to 2015 (Dry Year).

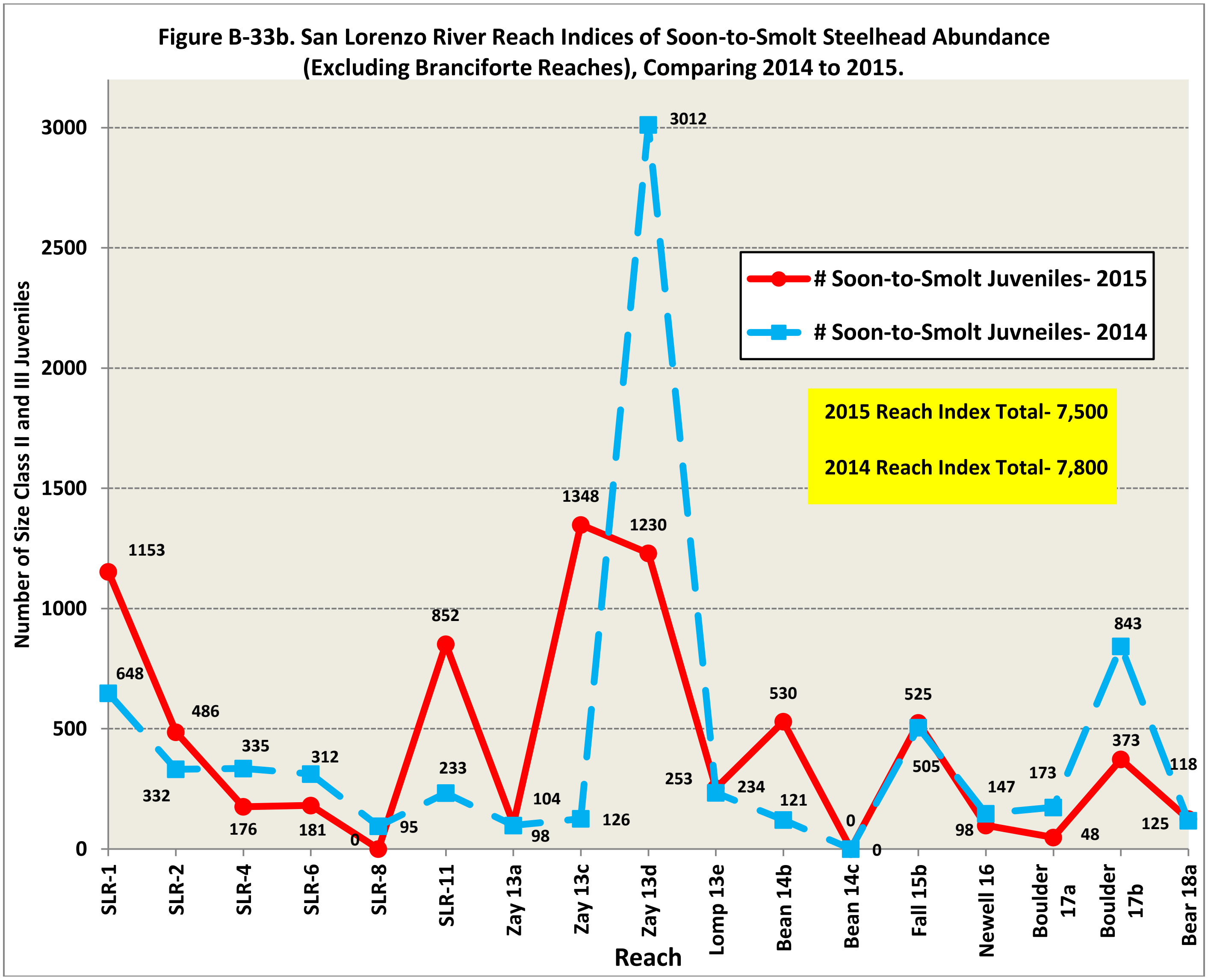

Figure B-33b. San Lorenzo River Reach Indices of Soon-to-Smolt Steelhead Abundance, Comparing 2014 to 2015.

Table B-42. 2015 Sampling Sites Rated by Potential Smolt-Sized Juvenile Density (=>75 mm SL) and Their Average Size in Standard Length Compared to 2014, with Physical Habitat Change Since 2014 Conditions.

Site	2014 Potential Smolt Density (per 100 ft)/ Avg Pot. Smolt Size SL	2014 Smolt Rating (With Size Factored In)	2015 Potential Smolt Density (per 100 ft)/ Avg Pot. Smolt Size SL	2015 Smolt Rating (With Size Factored In)	Physical Habitat Change by Reach/Site Since 2014
Low. San Lorenzo #0a	6.2/ 108 mm	Fair	4.8/ 83 mm	Poor	+
Low. San Lorenzo #1	1.8/ 125 mm	Poor	4.4/ 95 mm	Below Average	+
Low. San Lorenzo #2	2.4/ 98 mm	Poor	3.5/ 90 mm	Poor	+
Low. San Lorenzo #4	4.4/ 89 mm	Below Average	2.6/ 80 mm	Very Poor	–
Mid. San Lorenzo #6	1.4/ 80 mm	Very Poor	0.5/ 75 mm	Very Poor	+
Mid. San Lorenzo #8	1.4/ 92 mm	Very Poor	0/ 0 mm	Very Poor	+
Mid. San Lorenzo #9	0.6/ 92 mm	Very Poor	1.3/ 83 mm	Very Poor	+
Up. San Lorenzo #10	None	Very Poor	1.4/ 82 mm	Very Poor	+
Up. San Lorenzo #11	1.6/ 112 mm	Poor	5.8/ 98 mm	Below Average	+
Up.San Loren #12a (res. rt)		Not Sampled	6.8/ 97 mm	Below Average	NA
Zayante #13a	2.4/ 89 mm	Poor	2.1/ 86 mm	Very Poor	+ (Cover)
Zayante #13c	3.7/ 81 mm	Very Poor	44.7/ 87 mm	*Good*	+ (Cover)
Zayante #13d	22.1/ 93 mm	*Good*	8.3/ 97 mm	Fair	+ (Cover)
Lompico #13e	6.7/ 94 mm	Below Average	6.8/ 93 mm	Below Average	NA
Zayante #13i	Not Sampled	Not Sampled	7.4/ 112 mm	Fair	NA
Bean #14a	Not Sampled	Not Sampled	1.4/ 90 mm	Very Poor	NA
Bean #14b	2.8/ 101 mm	Poor	11.5/ 104 mm	*Good*	+
Fall #15a	2.7/ 103 mm	Below Average	6.0/ 99 mm	Below Average	+
Fall #15b	7.3/ 103 mm	Fair	6.7/ 95 mm	Below Average	+
Newell #16	3.1/ 109 mm	Below Average	2.0/ 86 mm	Very Poor	–
Boulder #17a	3.8/ 91 mm	Poor	1.0/ 106 mm	Poor	+
Boulder #17b	13.0/ 90 mm	Fair	5.7/ 88 mm	Poor	–
Bear #18a	0.7/ 116 mm	Poor	1.0/ 76 mm	Very Poor	+
Branciforte #21b	7.3/ 98 mm	Below Average	6.8/ 103 mm	Fair	–
Branciforte #21c (res. Rt)	13.3/103 mm	*Good*	6.2/ 115 mm	Fair	–
Soquel #1	0.7/ 102 mm	Very Poor	2.4/ 101 mm	Poor	–
Soquel #4	4.2/ 98 mm	Below Average	0.9/ 79 mm	Very Poor	–
Soquel #10	2.8/ 89 mm	Poor	0.5/ 76 mm	Very Poor	+
Soquel #12	2.8/ 95 mm	Poor	2.9/ 82 mm	Very Poor	–
East Branch Soquel #13a	4.3/ 100 mm	Below Average	9.1/ 91 mm	Fair	–
West Branch Soquel #19	2.4/ 92 mm	Poor	4.4/ 101 mm	Below Average	–
West Branch Soquel #21	4.7/ 87 mm	Poor	1.6/ 92 mm	Very Poor	–
Aptos #3	4.7/ 117 mm	Fair	3.5/ 112 mm	Below Average	+
Aptos #4	4.7/ 95 mm	Below Average	1.9/ 109 mm	Poor	–
Corralitos #1	8.3/ 97 mm	Fair	5.0/ 85 mm	Poor	–
Corralitos #3	12.1/ 95 mm	Fair	4.0/ 126 mm	Fair	+
Corralitos #8	6.1/ 97 mm	Below Average	2.2/ 105 mm	Below Average	–
Corralitos #9	8.3/ 94 mm	Fair	5.0/ 108 mm	Fair	+
Browns #1	6.6/ 106 mm	Fair	4.8/ 126 mm	Fair	+
Browns #2	7.2/ 92 mm	Below Average	5.4/ 106 mm	Fair	+

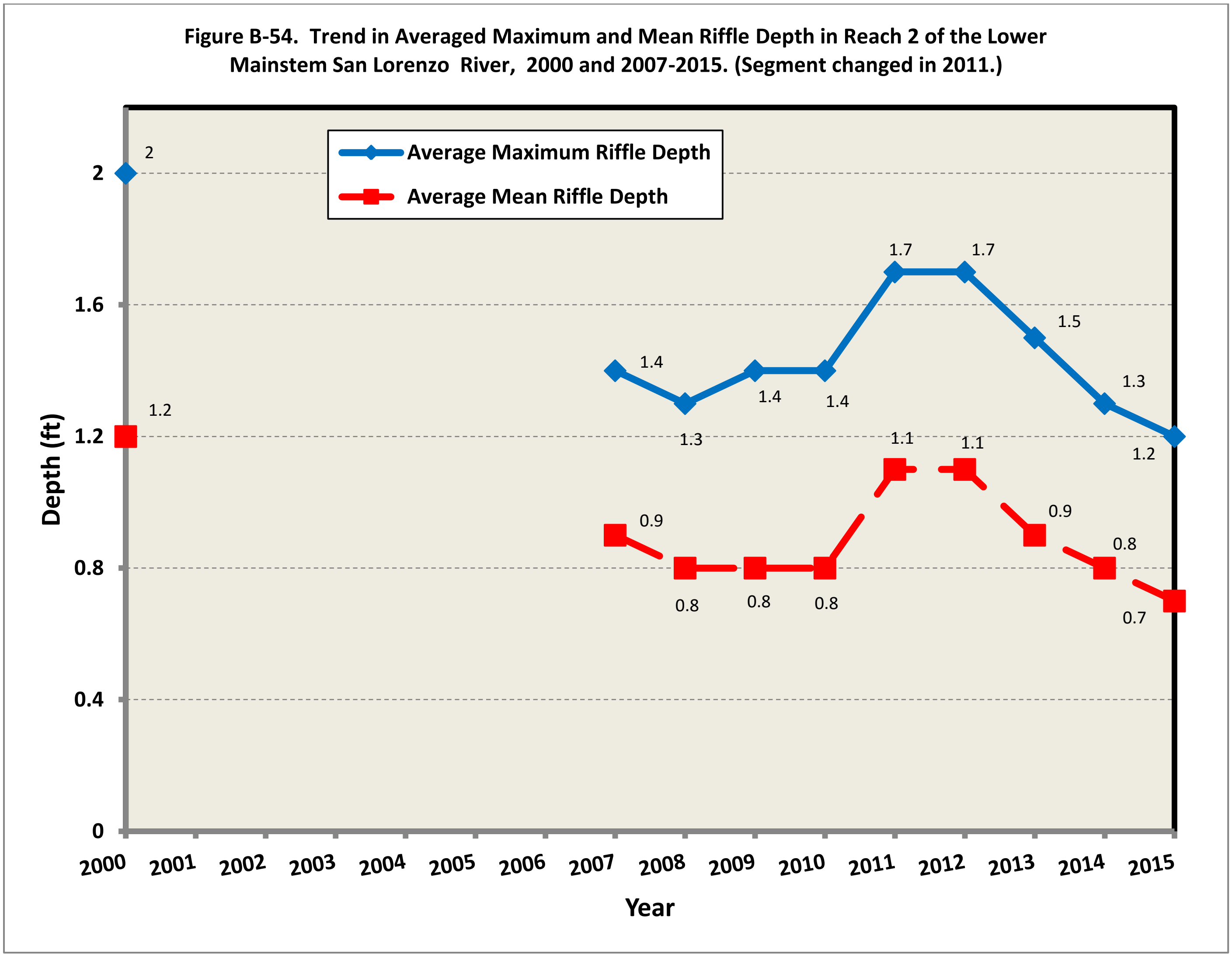

Figure B-54. Trend in Averaged Maximum and Mean Riffle Depth in Reach 2 of the Lower Mainstem San Lorenzo River, 2000 and 2007-2015.

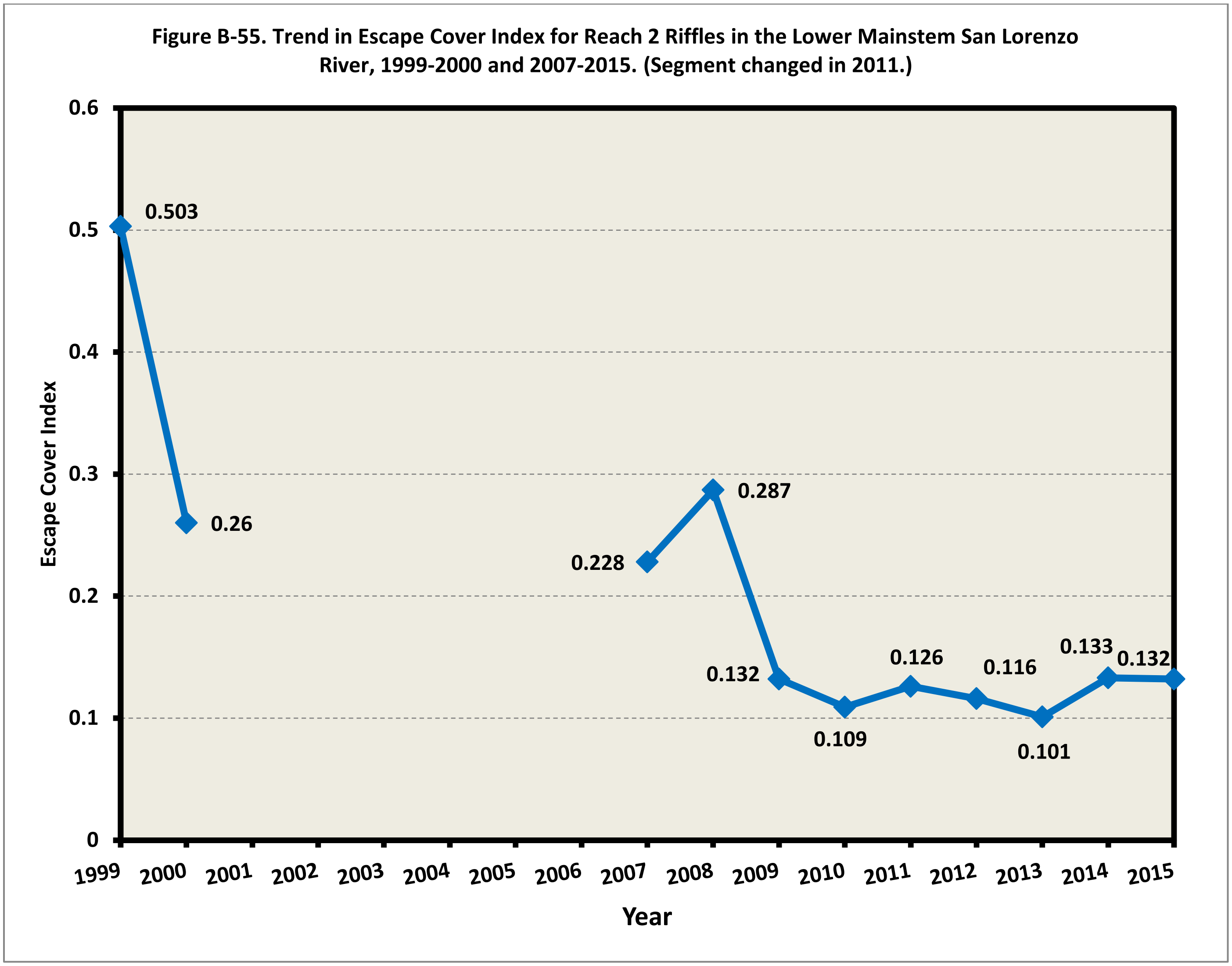

Figure B-55. Trend in Escape Cover Index for Reach 2 Riffles in the Lower Mainstem San Lorenzo River, 1999-2000 and 2007-2015.

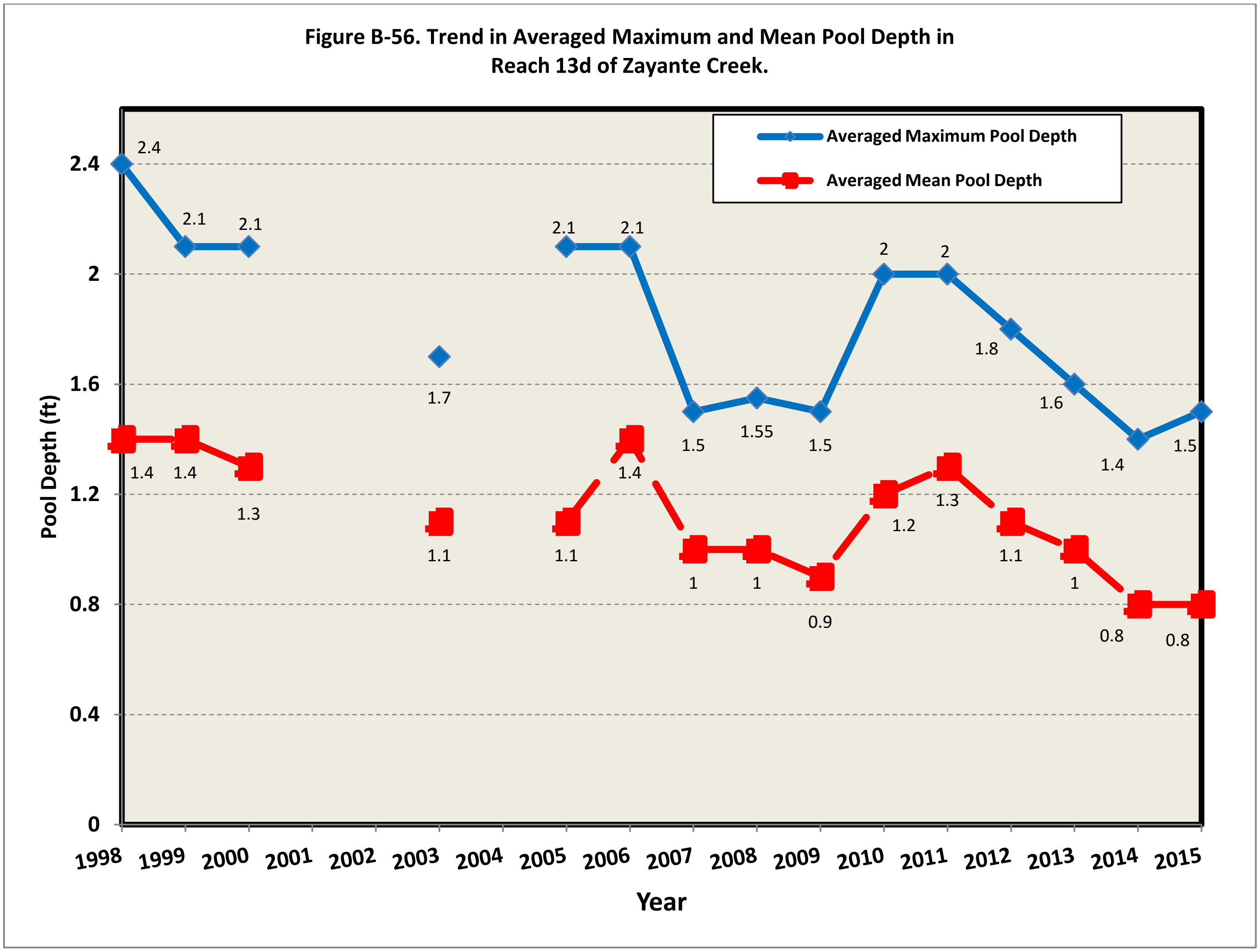

Figure B-56. Trend in Averaged Maximum and Mean Pool Depth in Reach 13d of Zayante Creek.

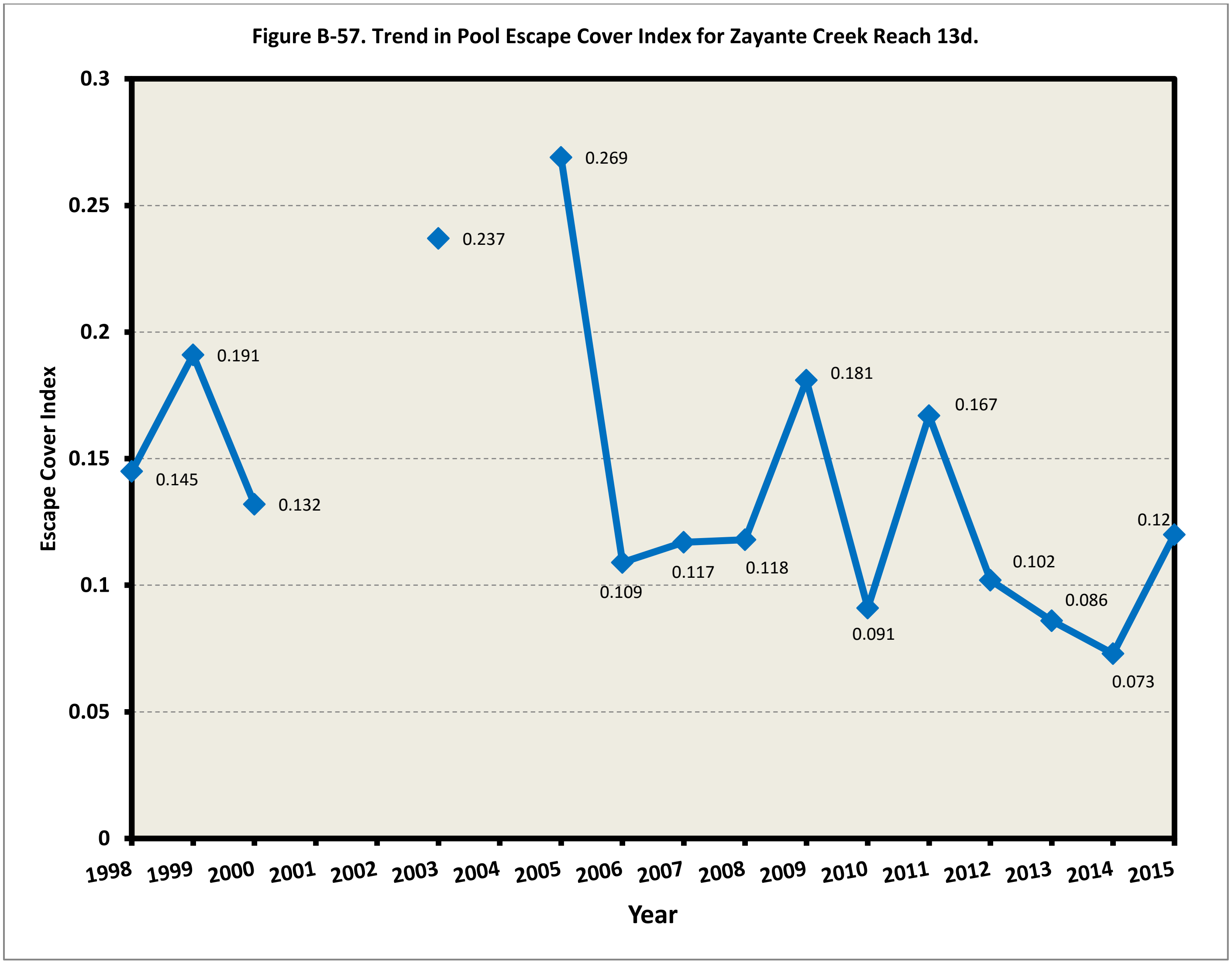

Figure B-57. Trend in Pool Escape Cover Index for Zayante Creek Reach 13d.

iii. Steelhead Abundance in the Soquel Creek Watershed

1. WY2015 streamflows in spring-summer-fall were well below the median flow statistic, as they had been in WY2013 and WY2014. December was wet with several storms, the largest creating stormflow of approximately 1,200 cfs at Soquel Village. However, the only other elevated streamflow during the winter/spring was a 5-7 day period in early February, when stormflow reached approximately 1,400 cfs (***Figures 39a-b*** *below*). Baseflow steadily declined from mid-April on (less than 10 cfs, initially except for small stormflows of less than 20 cfs, down to near intermittency in September at the Soquel Village Gage). Streamflow was intermittent at Walnut Street Park in lower Soquel Creek in mid-September. Streamflow comparisons between years were made for San Lorenzo and Soquel stream gages, comparing annual 5-month averages (May − September) expressed in ***Figure B-45*** *above.* 2015 had the second lowest average in 19 years, just above the 2014 average. Fall baseflow was lower at most sites in 2015.

2. With low baseflow, food supply was less for YOY growth in 2015, especially in the important spring and early summer period. Low food levels resulted in a smaller proportion of YOY reaching Size Class II in 2015 than in wetter year (***Figure 18a*** *below*). Baseflow was higher early in the dry season than it had been in 2014, but it declined more rapidly in 2015 to a lower level by September.

3. Although the important habitat parameter, pool escape cover, improved in 4 of 7 sites/reaches in 2015, pool depth and baseflow declined at 6 of 7 sites (***Table B-15g*** *below*). This resulted in negative overall habitat change at 6 of 7 sites/reaches in 2015 compared to past years. Only Site 10 in the mainstem had positive habitat change. and substrate conditions (percent fine sediment and embeddedness) were similar or improved compared to recent years in mainstem sites/ reaches, the overall rearing habitat quality of the watershed was poorer due to much lower baseflow (less food) and reduced pool depth (***Tables 5b, 14b, 15d, 15f in Appendix B***). Much of the East Branch Soquel went dry in 2015, as it had done in 2014, with its often important contribution of soon-to-smolt size fish as fast growing YOY in Reach 9a and its contribution of relatively higher densities of yearlings from Reach 12a lost in both years. Reach 12a has also produced high densities of YOY in the past.

4. ***Total and YOY densities*** were below average at 5 of 8 sites in 2015 and increased at 6 of 7 sampled sites compared to 2014 (***Tables 26 and 27 in Appendix B; Figures B5 and B6*** *below*). The increased YOY densities were statistically significant (***Table 46 in Appendix B***). Site 16 in the SDSF was dry again in 2015 as in 2014. Three-quarters of lower East Branch Reach 9a was also dry again in 2015 as in 2014. The trend in total densities (consisting of mostly YOY) for the watershed showed a slight upswing in 2015 (**Figure B-25** *below*). Total densities have steadily declined through the years at the SDSF Site 16 to zero in 2014 and 2015, when Reach 12a went dry.

5. ***Yearling densities*** in 2015 were below average and declined from 2014 at 4 of 7 sites (***Table 28 in Appendix B;*** **Figure B-7** *below*). Yearling density was still very low at all sites (maximum of 4.4 yearlings/ 100 ft at Site 19 on the West Branch).

6. ***Size Class II and III juvenile densities*** were below average at all 8 sites and increased at 4 of 7 sampled sites compared to 2014 (***Table 30 in Appendix B;*** **Figure B-8** *below*). The trend in Size Class II and III (soon-to-smolt) densities has fluctuated through the years, mostly depending on the number of YOY reaching soon-to-smolt size, which is positively related to streamflow. The trend increased very slightly from 2012 to the second lowest 6-site average (2.6 fish/ 100 ft) since 1997 (**Figure B-26a** *below*). Based on soon-to-smolt size densities, 4 of 7 sampled sites decreased in ratings compared to 2014, and Site 16 was dry (**Table B-42** *above*). The 7 sampled sites ranged in ratings from "very poor" (4 sites) to "fair" (1 site below Mill Pond on the East Branch).

7. Soquel Lagoon is typically habitat for a sizeable juvenile steelhead population, as indicated by our long-term population censusing for the City of Capitola which indicated a long-term average population size of 1,600 soon-to-smolt sized steelhead between 1993 and 2013 (**Alley 2016**). However, only 10 juveniles were captured in Soquel Lagoon in 2014 and 15 in 2015, without recaptures both years. The 2014 and 2015 population sizes were likely less than 100 soon-to-smolt sized steelhead. This likely indicated limited spawning and/or poor spawning success in reaches near the lagoon.

8. The abundance index for soon-to-smolt steelhead in sampled reaches decreased from 2010 (3,800) to 2014 (880) to 2015 (580) (***Figure B-34a-b*** *below*). The 85% reduction between 2010 and 2015 resulted primarily from very low YOY growth in 2015 in high growth potential reaches (mainstem Soquel, lower East and West Branches) and the dry stretches in the East Branch, thus providing much fewer YOY to the Size Class II compared to 2010. When averaged soon-to-smolt site densities were plotted annually with the 5-month average baseflow (May through September), densities increased during some wet years and decreased in some dry years (***Figure B-26b*** *below*). Much fewer yearlings remained in 2015 because much of the dry sections in the East Branch, especially in Reach 12a in the Soquel Demonstration State Forest went dry. This further reduced the index, as it had in 2014. Although the trend in 6-site average of Size Class II and III densities increased slightly from 2014 to 2015, the abundance index decreased. This shows the value of abundance indices in denoting trends in potential smolt production, with reach lengths and dry sections taken into account.

9. Juvenile coho salmon were captured incidentally and released at Site # 12 (upper mainstem) and at lower West Branch Site #19. They were larger than most YOY steelhead, indicating that adult coho may have entered the system during the December storms.

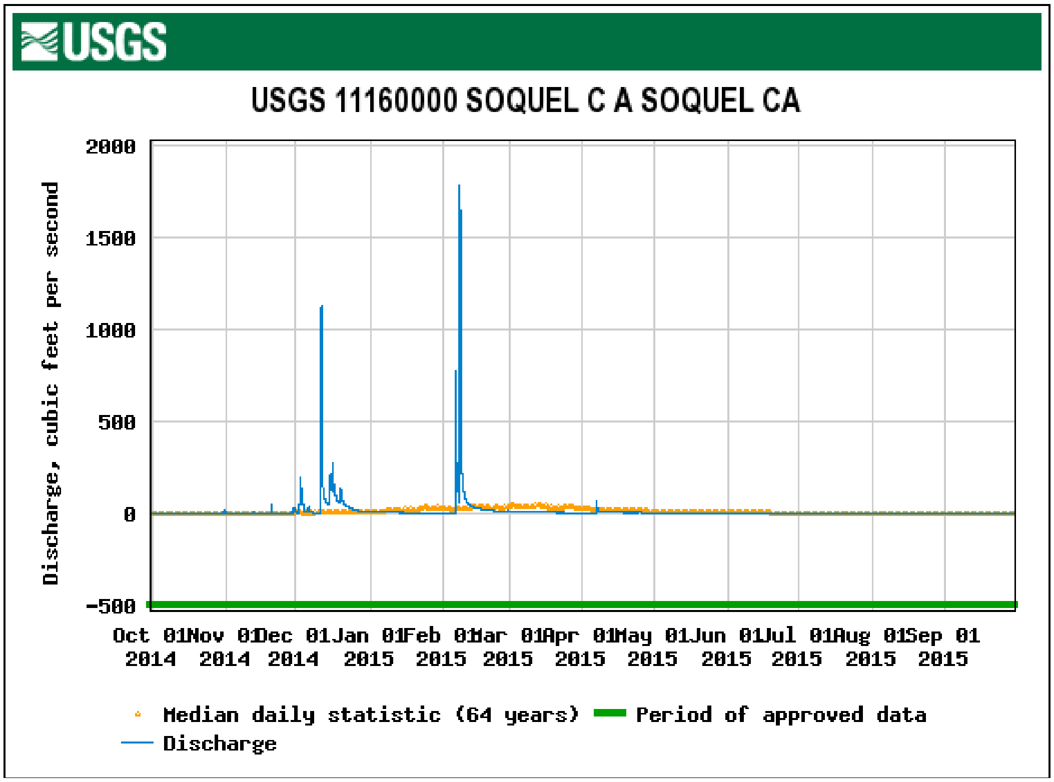

Figure B-39a. The 2015 Discharge at the USGS Gage on Soquel Creek at Soquel Village.

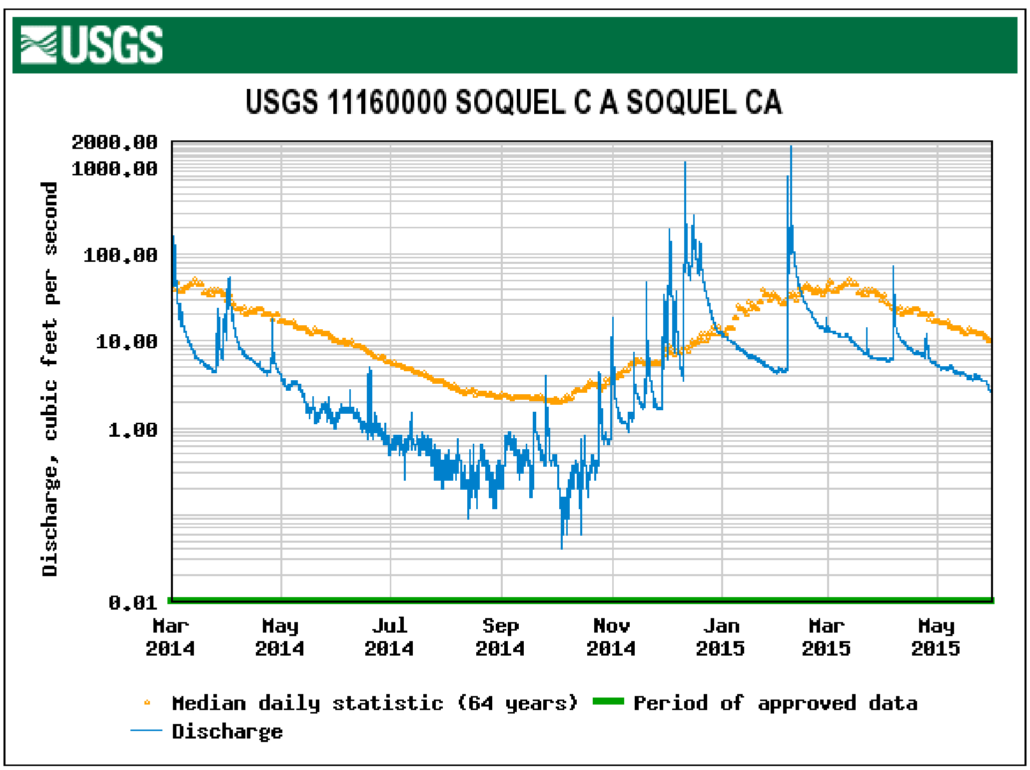

Figure B-39b. The 2015 Discharge to 31 May at the USGS Gage on Soquel Creek at Soquel Village.

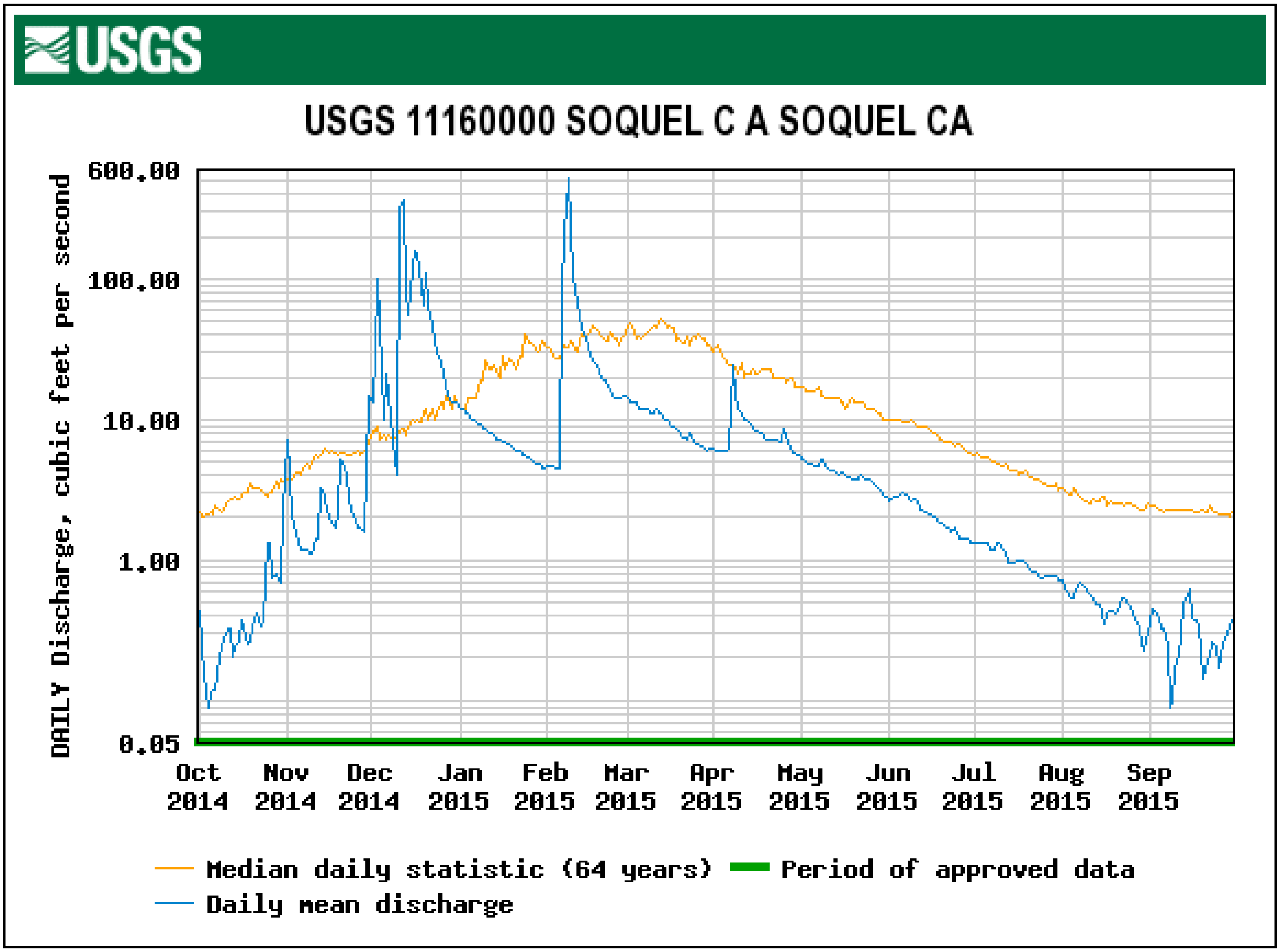

Figure B-39c. The 2015 Daily Mean and Median Flow at the USGS Gage on Soquel Creek at Soquel Village.

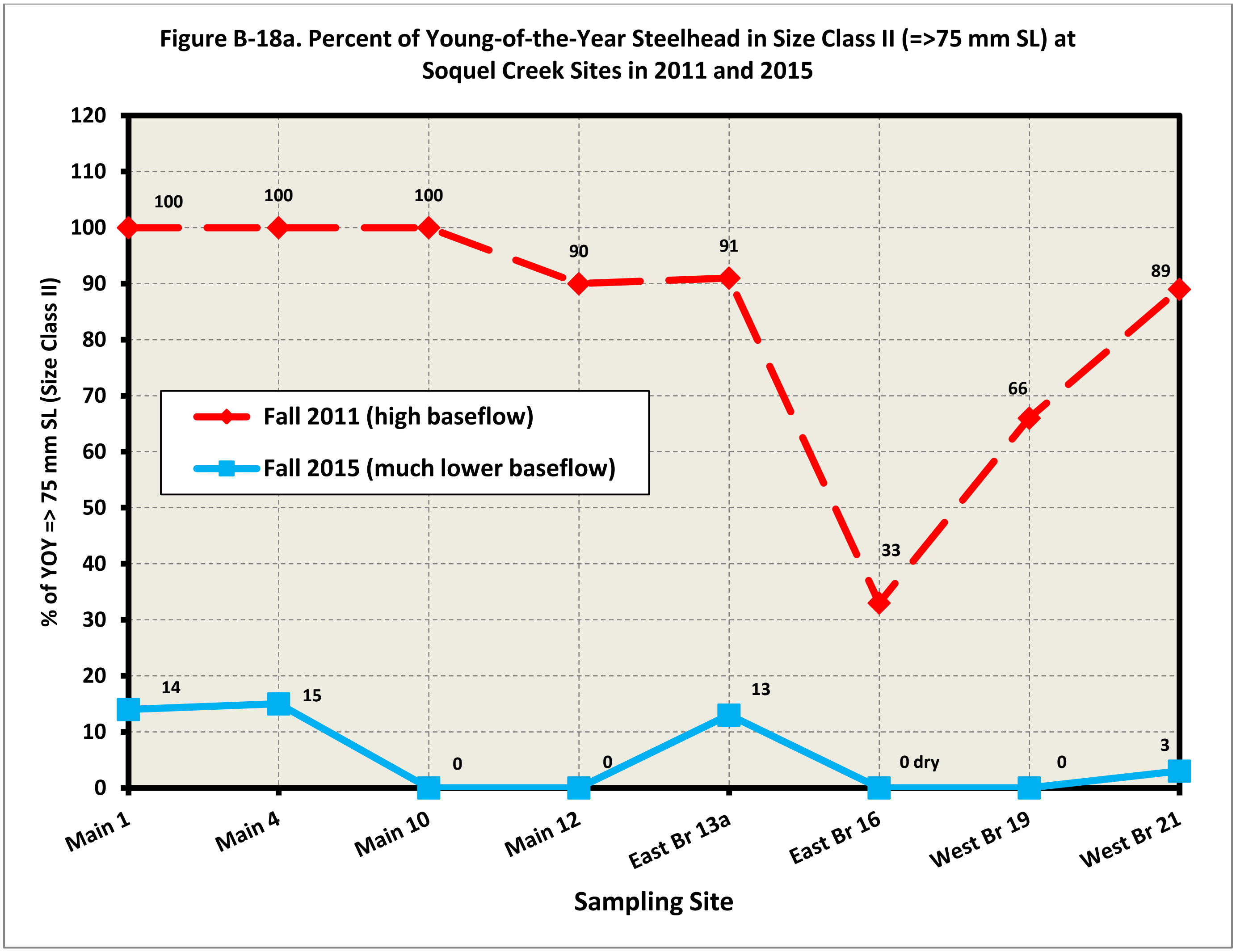

Figure B-18a. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Soquel Creek Sites in 2011 and 2015.

Table 15g. Habitat Change in SOQUEL CREEK WATERSHED Reaches (2012 to 2015 or 2013 to 2015) or Replicated Sites (2014 to 2015).

Reach Comparison or (Site Only)	Baseflow Avg. May-September	Pool Depth	Fine Sediment	Embeddedness	Pool Escape Cover	Overall Habitat Change
(Site 1) Reach 1	+ then very − later	−	Similar	+ pools	+	−
Site 4 Reach 3a	−Compared to 2013	− Since 2013	+ run Since 2013	Similar Since 2013	−	−
(Site 10) Reach 7	+ Similar	+	− run	− Pool and riffle	Similar	+
Site 12 Reach 8	−Compared to 2013	− avg. + max.	+ pool Since 2013	Similar Since 2013	+ Since 2013	−
(Site 13a) Reach 9a	+ then very − later	−	+ pool and run	Similar	+	−
Site 16 Reach 12a	Dry	Dry	Dry	Dry	Dry	Dry 2014 and 2015
Site 19 W. Br. Reach 13	− Compared to 2012	− Since 2012	− (pool) Since 2012	Similar Since 2012	+ Since 2012	−
(Site 21) W. Br. Reach 14b	+ then very − later	−	− (pool)	+ pool −run	+	−

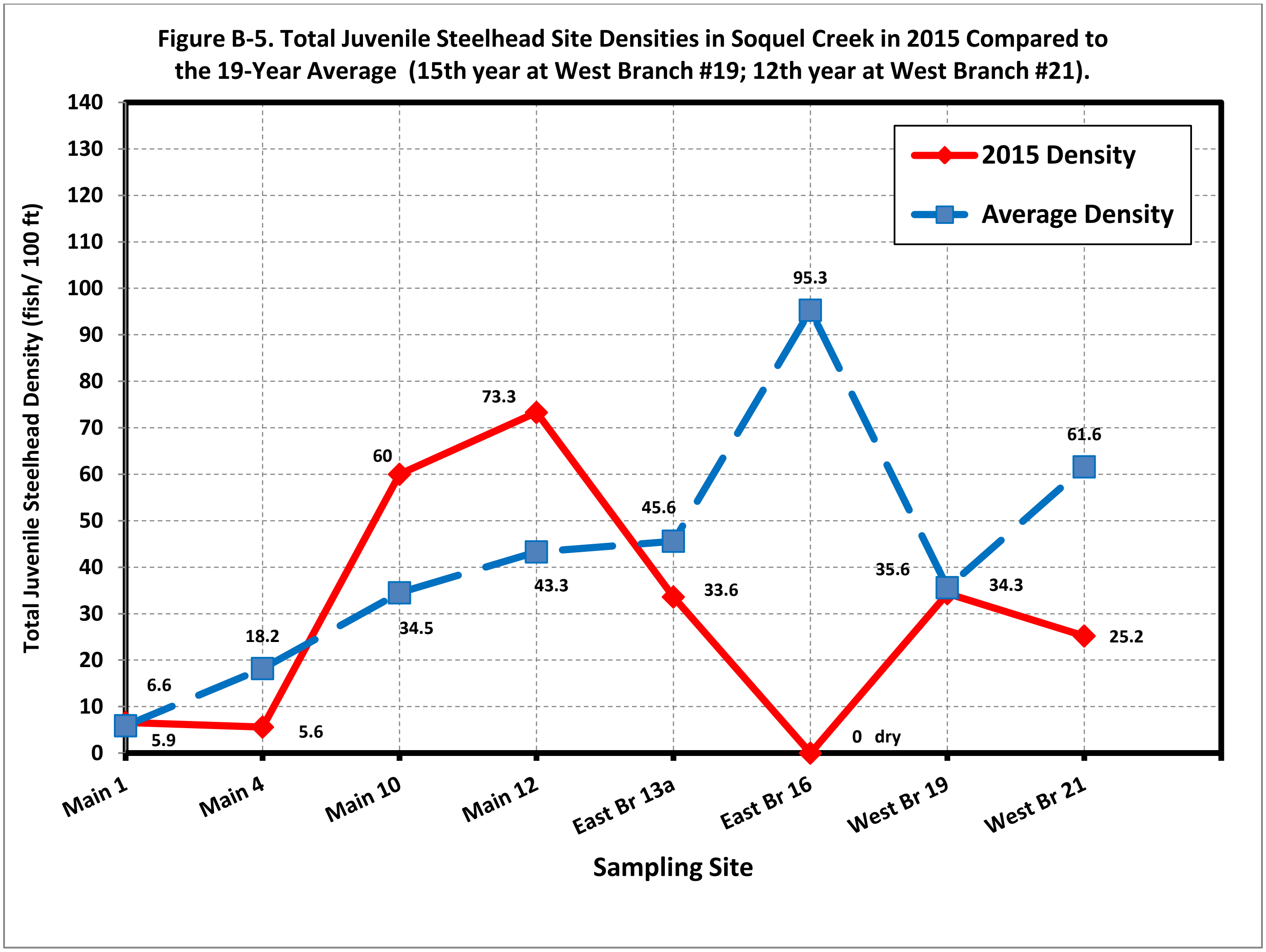

Figure B-5. Total Juvenile Steelhead Site Densities in Soquel Creek in 2015 Compared to the 19-Year Average (15th year at West Branch #19).

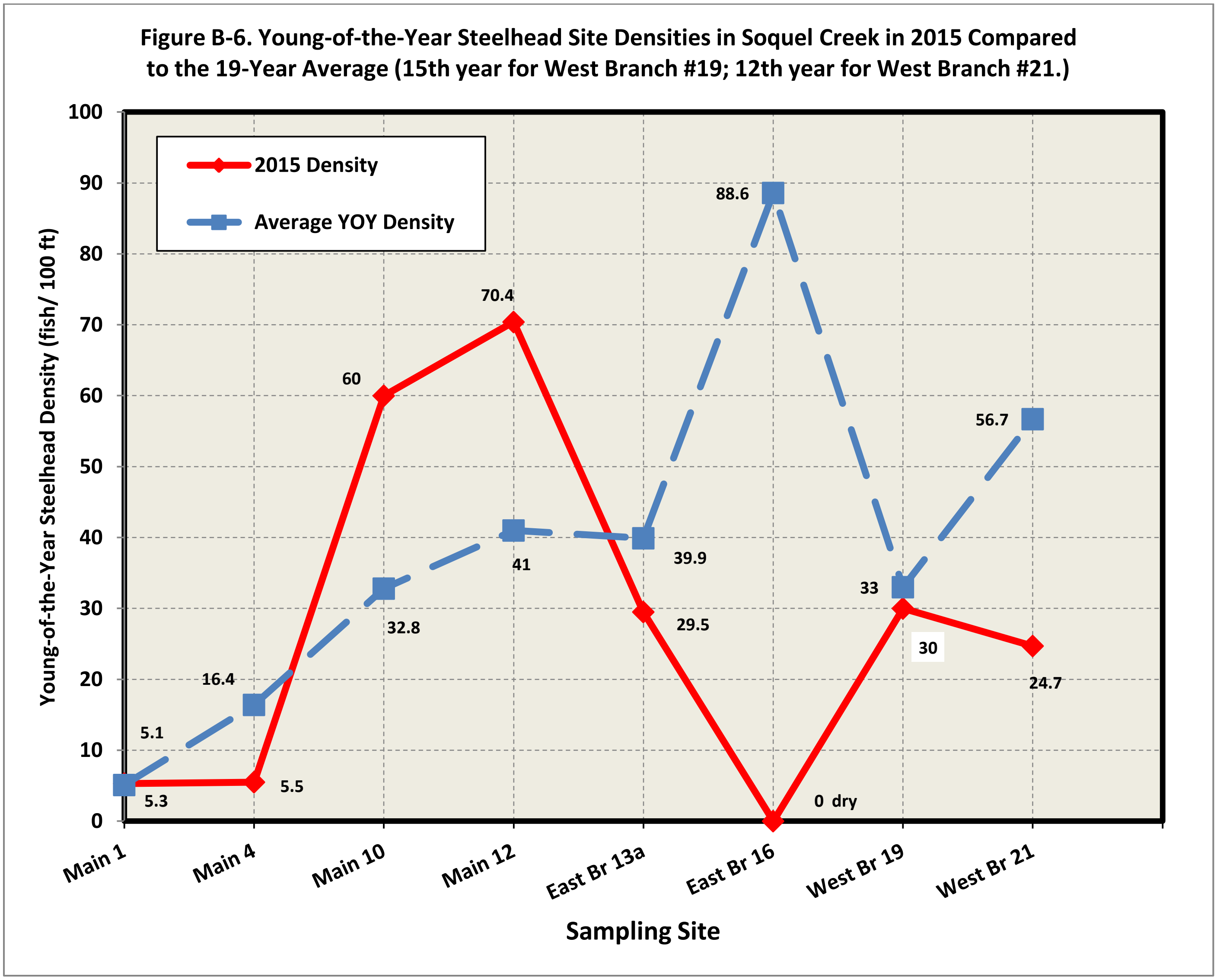

Figure B-6. Young-of-the-Year Steelhead Site Densities in Soquel Creek in 2015 Compared to the 19-Year Average (15th year for West Branch #19.)

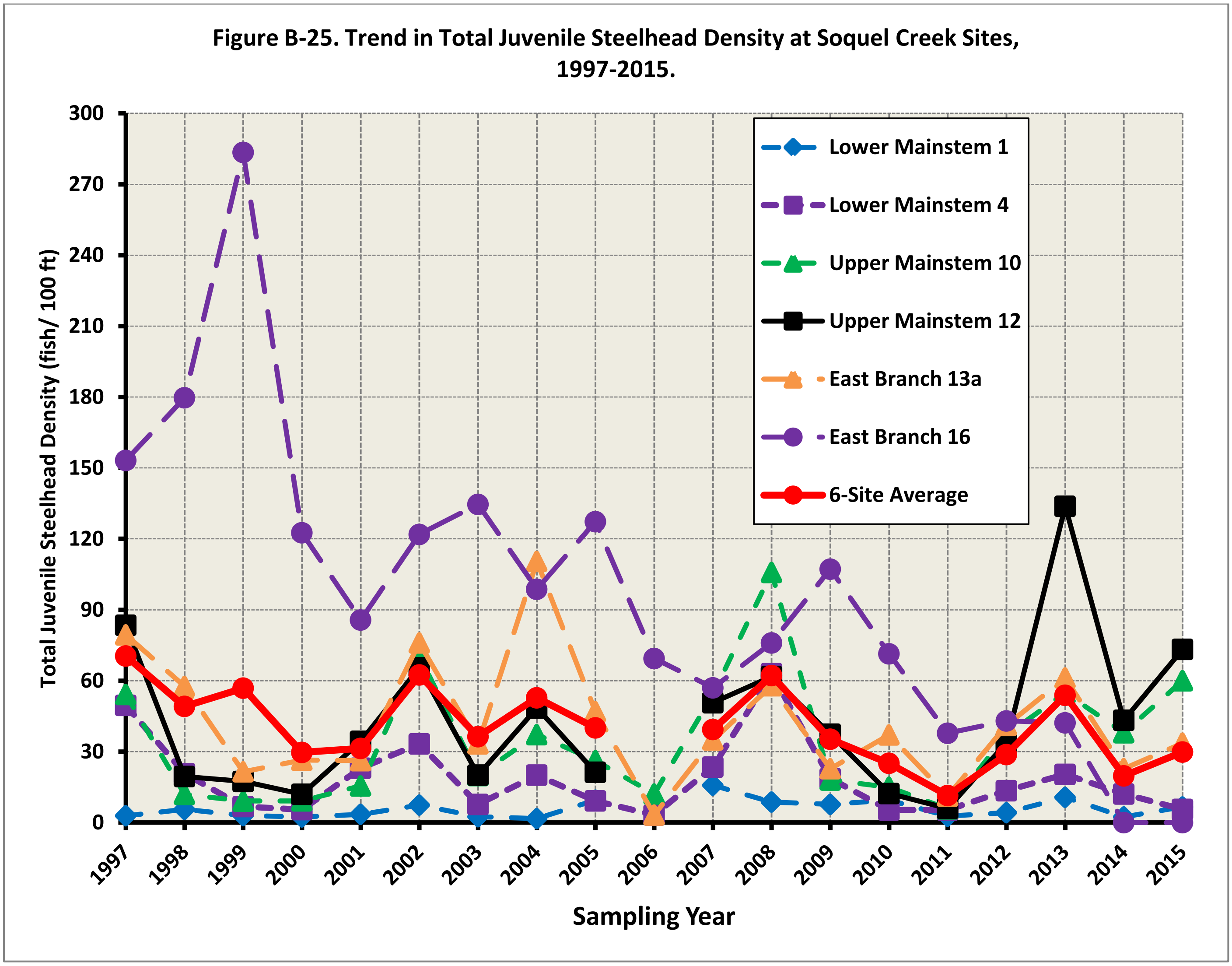

Figure B-25. Trend in Total Juvenile Steelhead Density at Soquel Creek Sites, 1997-2015.

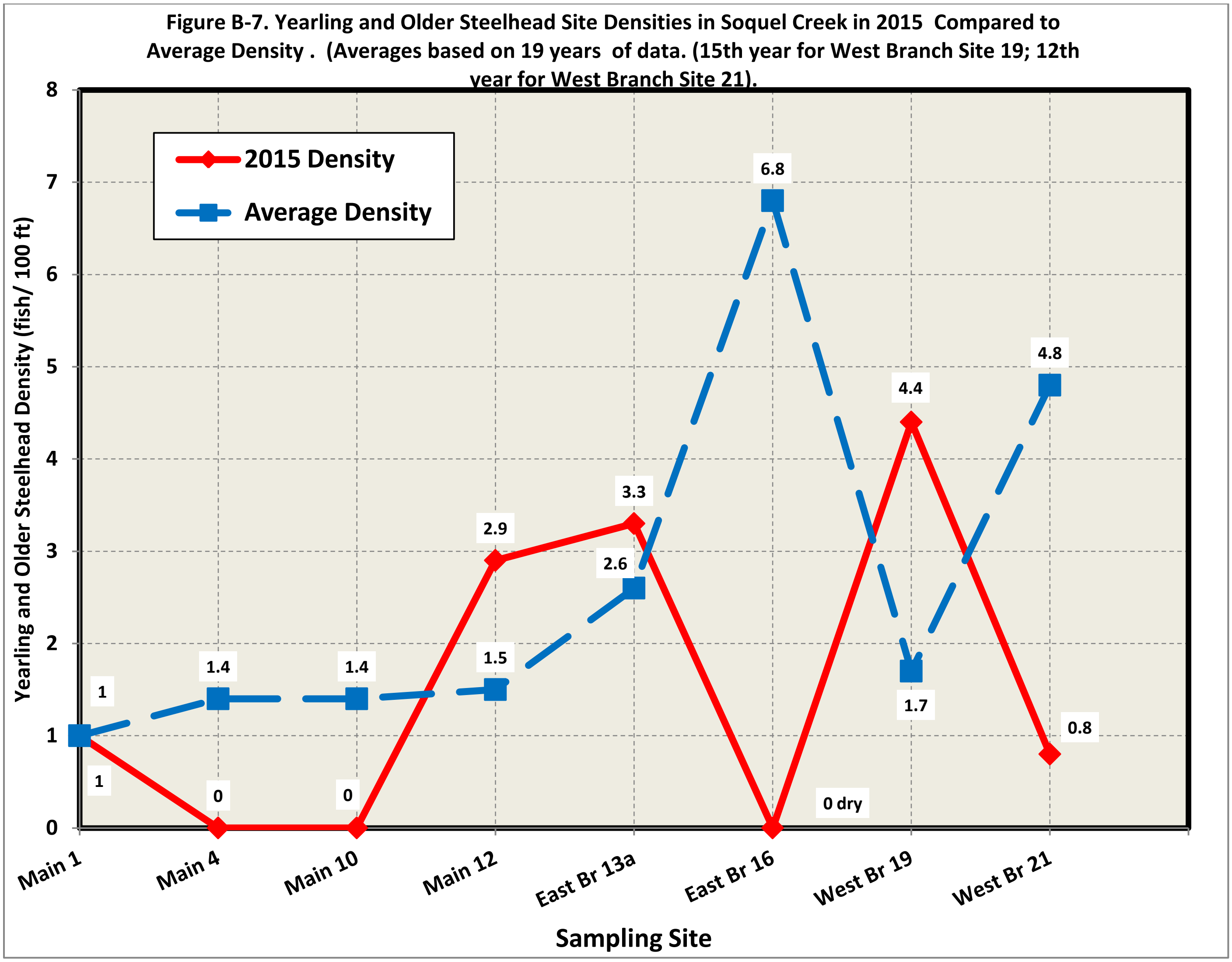

Figure B-7. Yearling and Older Steelhead Site Densities in Soquel Creek in 2015 Compared to Average Density. (Averages based on 19 years of data. (15th year for West Branch Site 19).

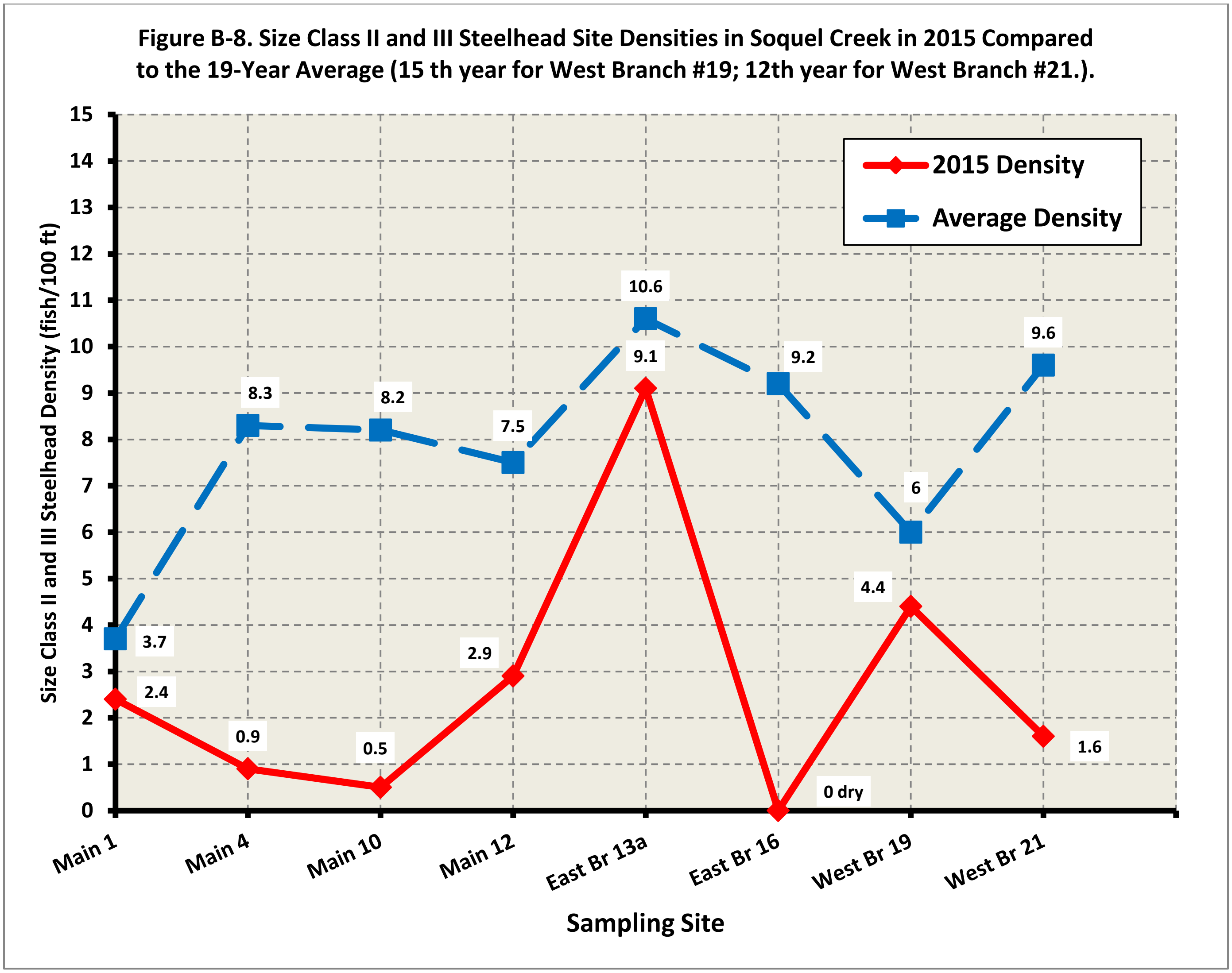

Figure B-8. Size Class II and III Steelhead Site Densities in Soquel Creek in 2015 Compared to the 19-Year Average (15th year for West Branch #19.)

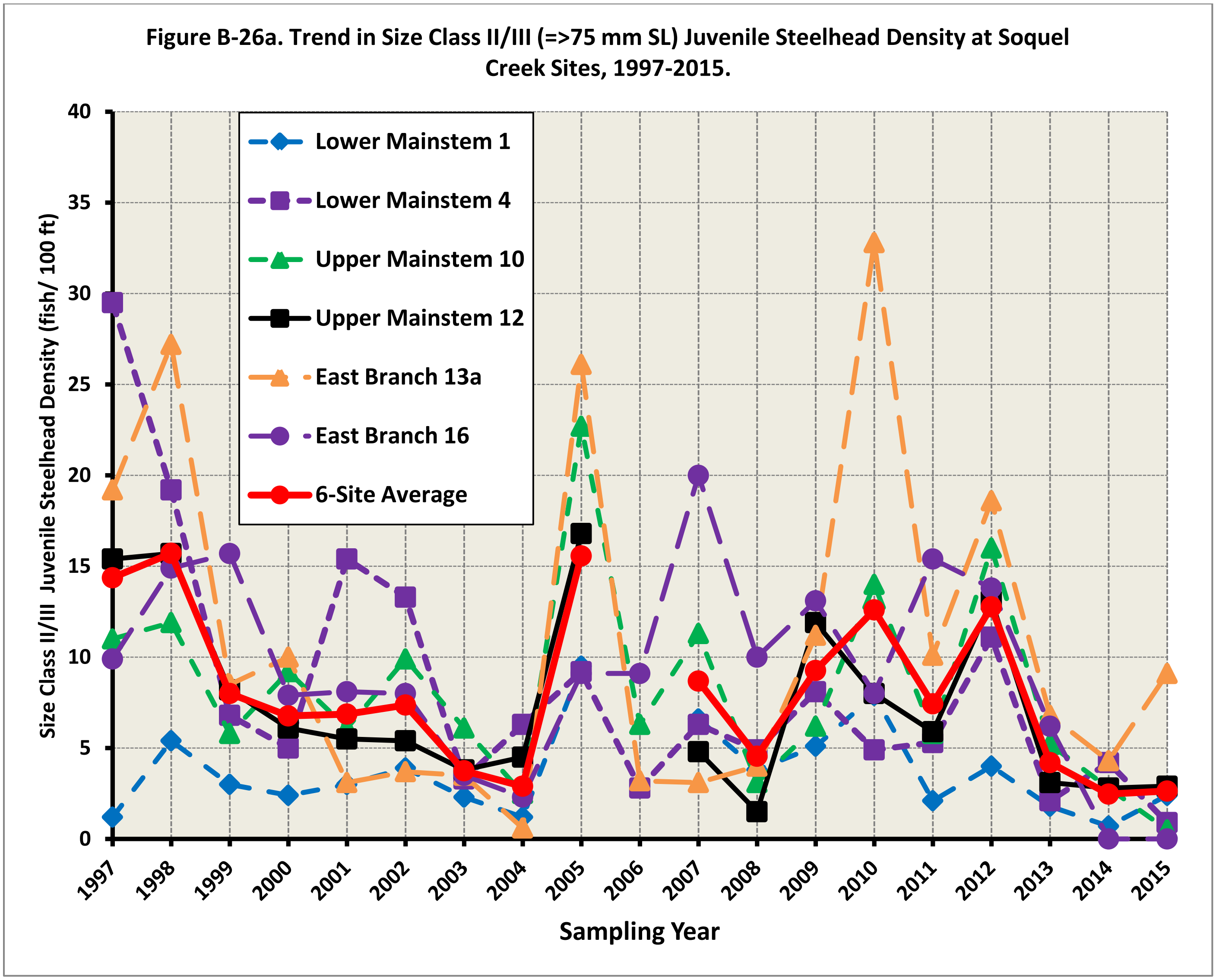

Figure B-26a. Trend in Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at Soquel Creek Sites, 1997-2015.

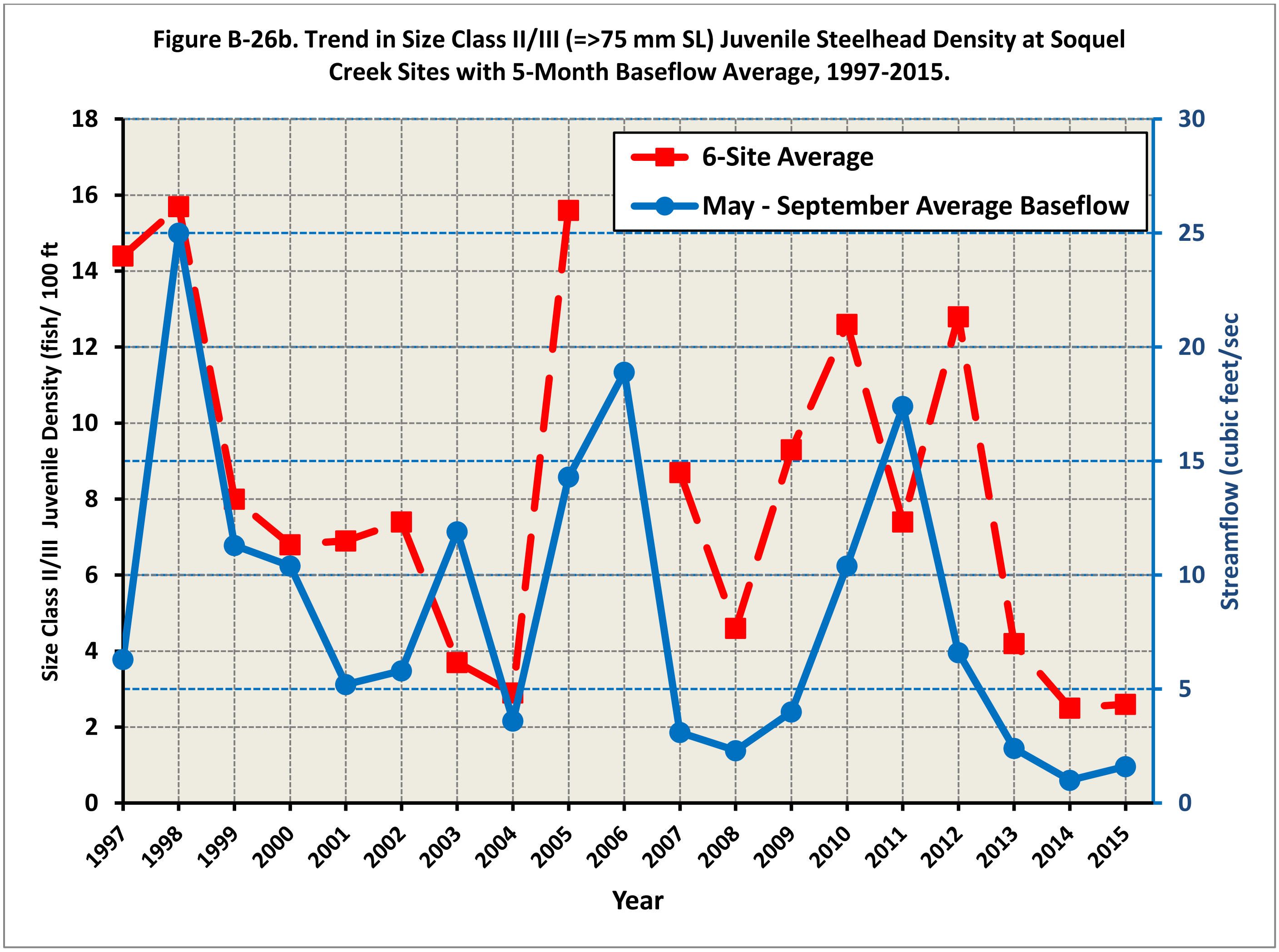

Figure B-26b. Trend in Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at Soquel Creek Sites with 5-Month Baseflow Average, 1997-2015.

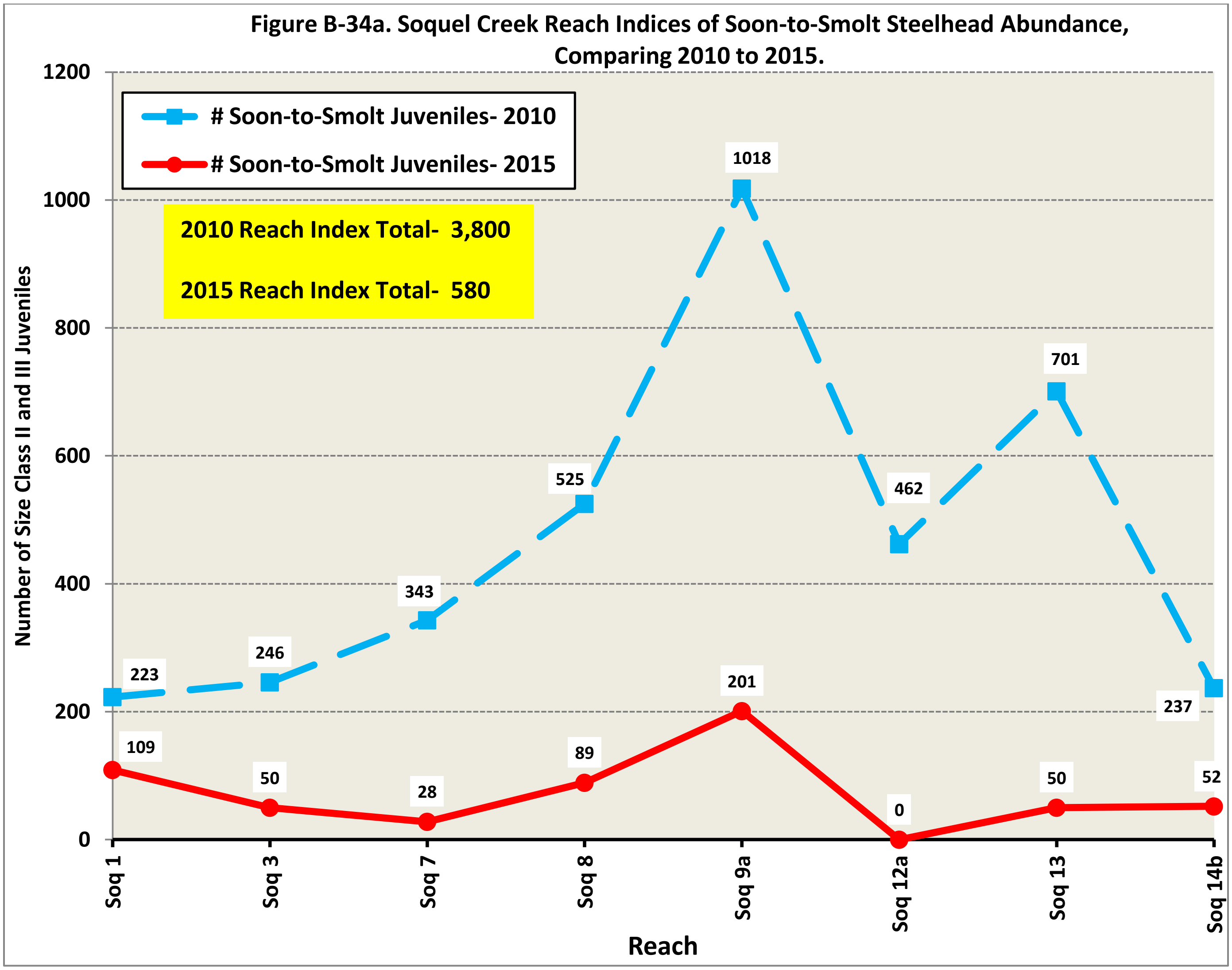

Figure B-34a. Soquel Creek Reach Indices of Soon-to-Smolt Steelhead Abundance, Comparing 2010 to 2015.

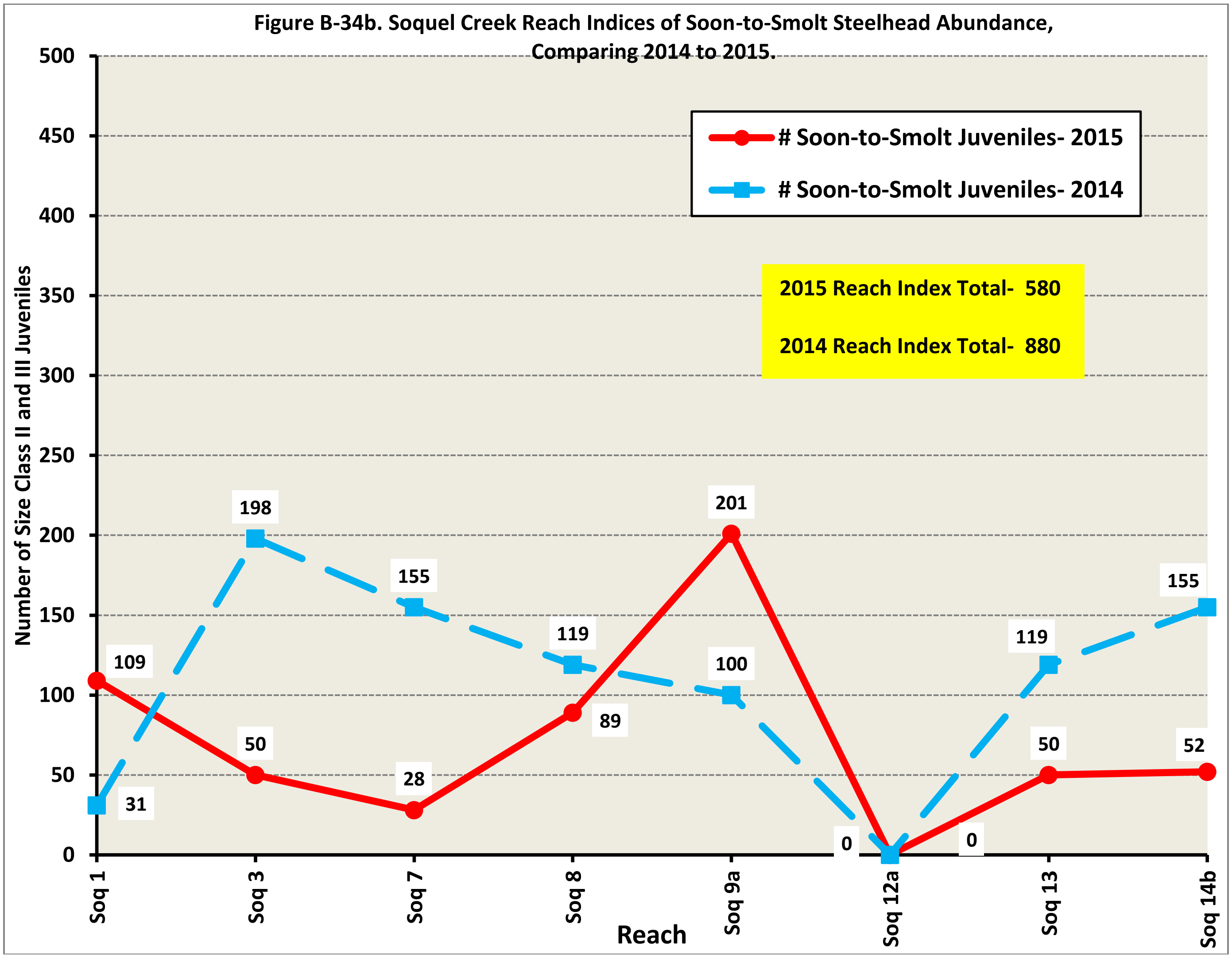

Figure B-34b. Soquel Creek Reach Indices of Soon-to-Smolt Steelhead Abundance, Comparing 2014 to 2015.

iv. Steelhead Abundance and Habitat in the Aptos Creek Watershed

1. Based on hydrographs from stream gages in other watersheds (***Figures 36-41 in Appendix B***), it is likely that this watershed also had similarly lower baseflow in 2015 similar to 2014, probably well below the median baseflow in spring-summer-fall. This provided low food availability. Measured streamflow in fall in Aptos Creek confirmed lower baseflow than in either 2013 or 2014 (***Table 5b in Appendix B***).

2. ***Habitat quality*** was slightly improved compared to 2014 at both the lower Aptos Site 3 above Valencia Creek confluence and in the upper Aptos segment 3 (with Site 4) in Nisene Marks due to increased pool depth in both and increased escape cover at Site 4, though baseflow was reduced (***Tables 16a-b in Appendix B; Table B-16c*** *below*). Substrate conditions regarding percent fines and embeddedness were similar to previous measured conditions.

3. ***YOY and total densities*** decreased substantially in 2015 compared to 2014, in contrast to many sites in the other 3 Santa Cruz Mountain drainages. Juvenile steelhead densities were way below average with steelhead nearly absent (***Tables 31 and 32 in Appendix B; Figures B-9 and B-10*** *below*). Both Aptos sites had by far the lowest YOY and total densities in the past 11 years of sampling. The trend in total densities declined to a 10-year low in 2015 (1.8 juveniles/ 100 ft, averaged for 2 Aptos sites) (***Figure B-27*** *below*).

4. ***Yearling densities*** also declined in 2015 from past samplings and were below average at both Aptos sites (***Table 33 in Appendix B; Figure B-11*** *below*). In fact, no yearlings were detected at upper Aptos #4.

5. With low YOY and yearling densities and despite the high proportion of the few YOY reaching Size Class II, the ***Size Class II and III densities*** were well below average and less than in 2014 (Aptos sites) (***Table 35 in Appendix B; Figures B- 19a and B-12*** *below*). In Aptos Creek, the trend in average Size Class II and III density increased from 2008 to 2010, but declined to the low 4-site average of 6 fish/ 100 ft in 2014 (***Figure B-28*** *below*). The 2-site average for Aptos sites has declined steadily from 2010 to 2015 (22.1, 11.1, 10.6, 5.6, 4.7 and 2.7, respectively). Low soon-to-smolt densities were likely due to few YOY (likely few adult spawners resulting from poor smolt production in the lagoon over the years resulting from sandbar breaching, low inflow and poor lagoon water quality), low streamflow with reduced food and provided poor spawning conditions, few YOY in 2014 to be recruited as yearlings in 2015 and poor overwinter retention of yearlings. Soon-to-smolt ratings declined to "below average" at lower Aptos # 3 and to "poor" at upper Aptos #4 (***Table B-42*** *above*).

Table B-16c. Habitat Change in APTOS Reaches (2011 to 2015) AND CORRALITOS WATERSHED Reaches (2011− 2013 to 2015) and Replicated Sites in Both Watersheds (2014 to 2015).

Reach Comparison or (Site Only Comparison)	Baseflow	Pool Depth	Fine Sediment	Embeddedness	Pool Escape Cover	Overall Habitat Change
(Aptos Site 3) Aptos 3	+ early − late	+	Similar	Similar	Similar	+
(Aptos Site 4) Aptos 4	−	+	Similar	Similar	+	+
Corralitos Site 1 Corralitos R-1	− Compared to 2013	+ Since 2013	− Since 2013	Similar Since 2013	−	−
(Corralitos Site 3) Corralitos R-3	+ early Similar late	+ avg. depth	−	Similar	−	+
Corralitos Site 8 Corralitos R- 5/6	− Compared to 2012	− Since 2012	Similar Since 2012	Similar Since 2012	− Since 2012	−
(Corralitos Site 9) Corralitos R-7	+ early − late	+ avg. depth	Similar	Similar	+	+
Shingle Mill Site 1						NA
Shingle Mill Site 3 above fault line						NA
(Browns Site 1) Brown R-1	+ early − late	+ max. depth	Similar	Similar	+	+
(Browns Site 2) Brown R-2	+ early − late	+	Similar	Similar	Similar	+

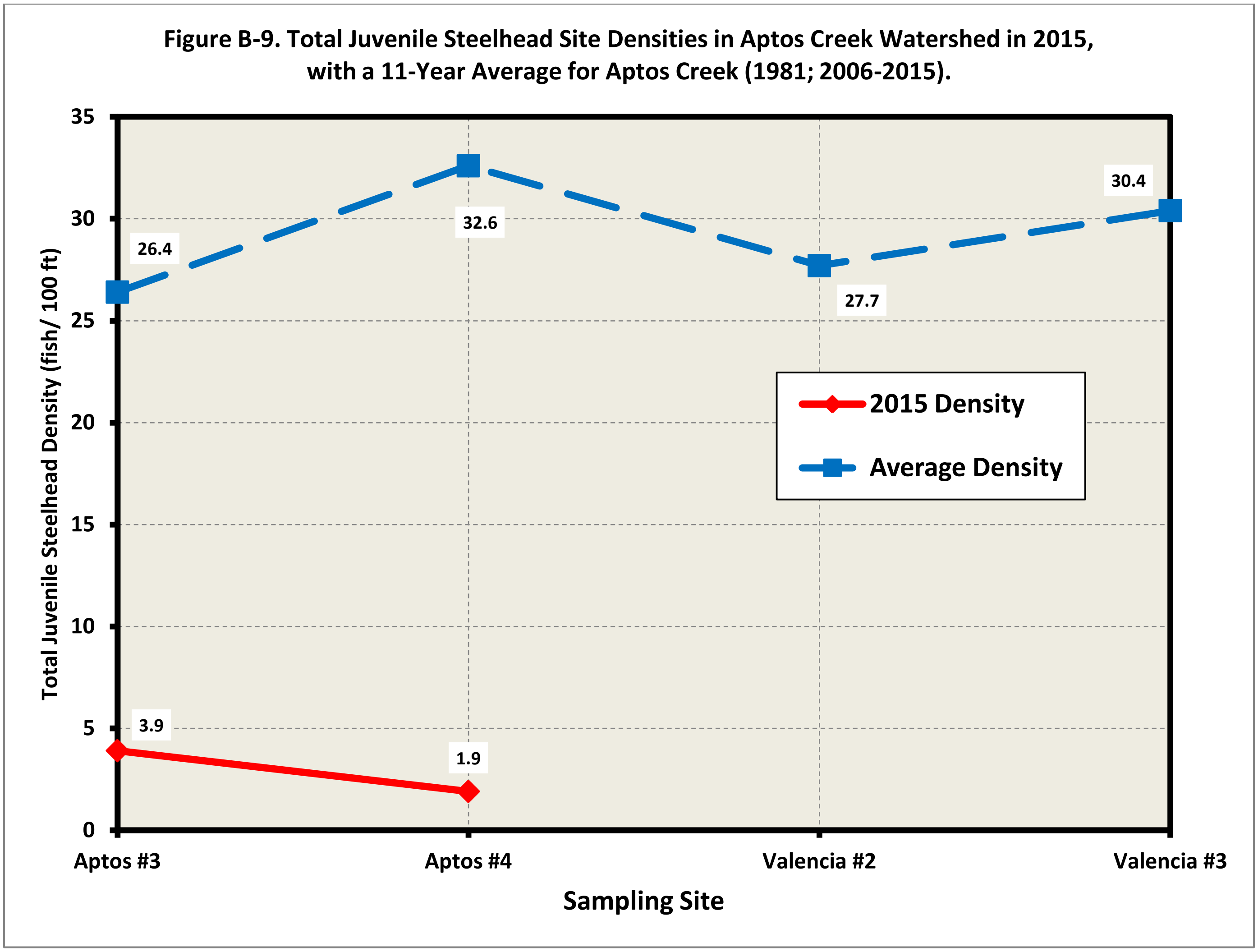

Figure B-9. Total Juvenile Steelhead Site Densities in Aptos Creek in 2015, with an 11-Year Average (1981; 2006-2015).

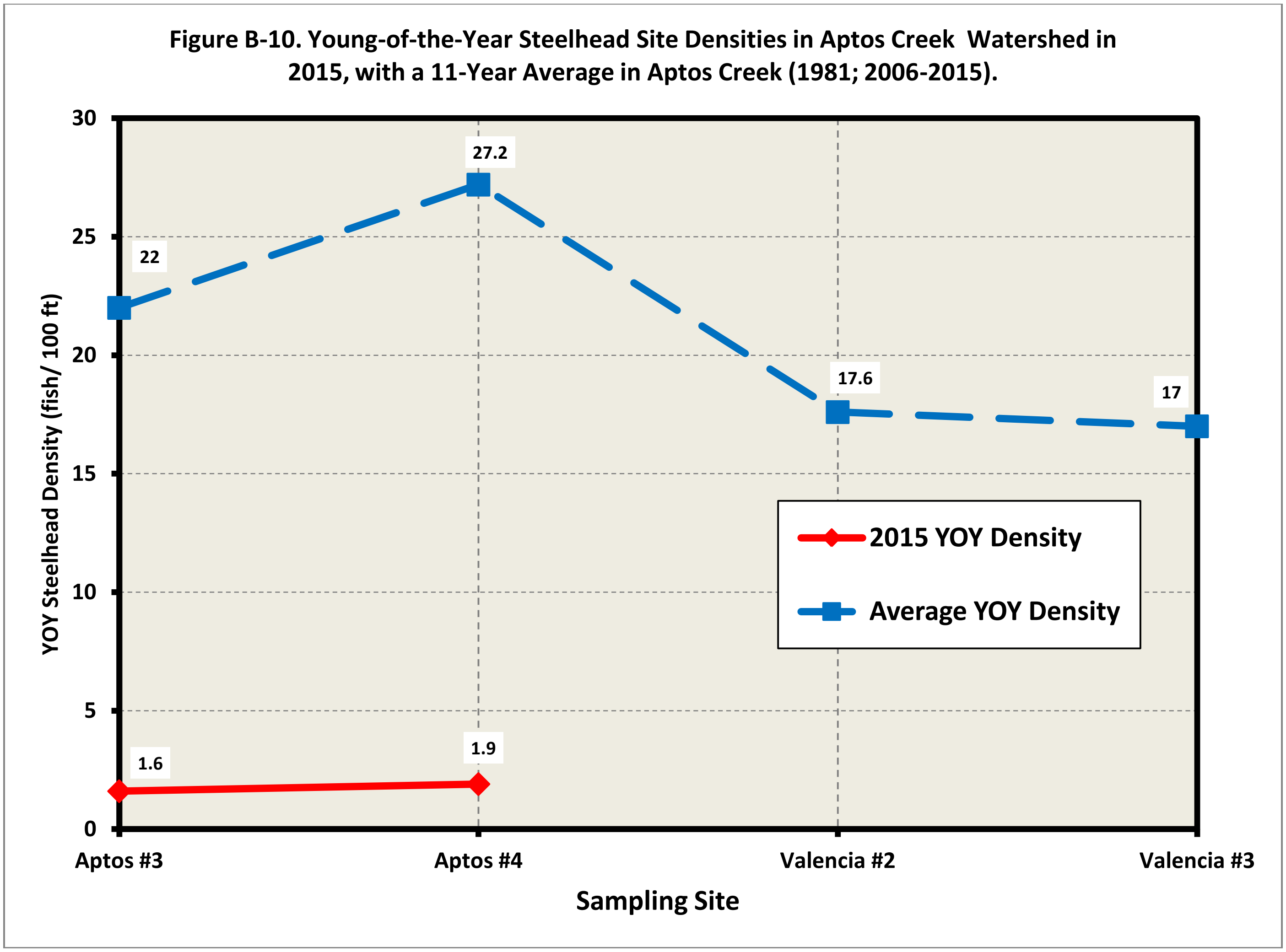

Figure B-10. Young-of-the-Year Steelhead Site Densities in Aptos Creek in 2015, with an 11-Year Average (1981; 2006-2015).

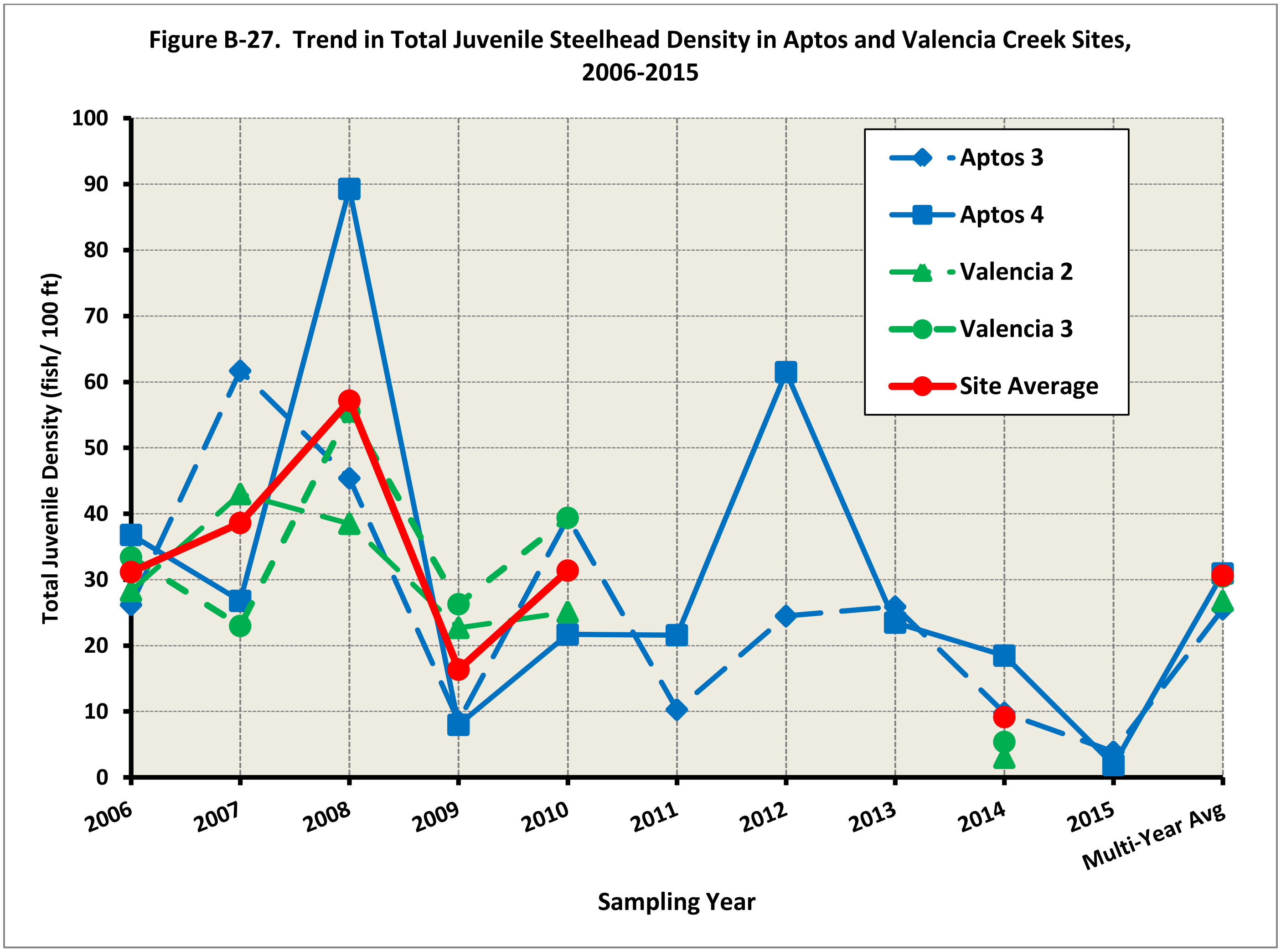

Figure B-27. Trend in Total Juvenile Steelhead Density in Aptos and Valencia Creek Sites, 2006-2015.

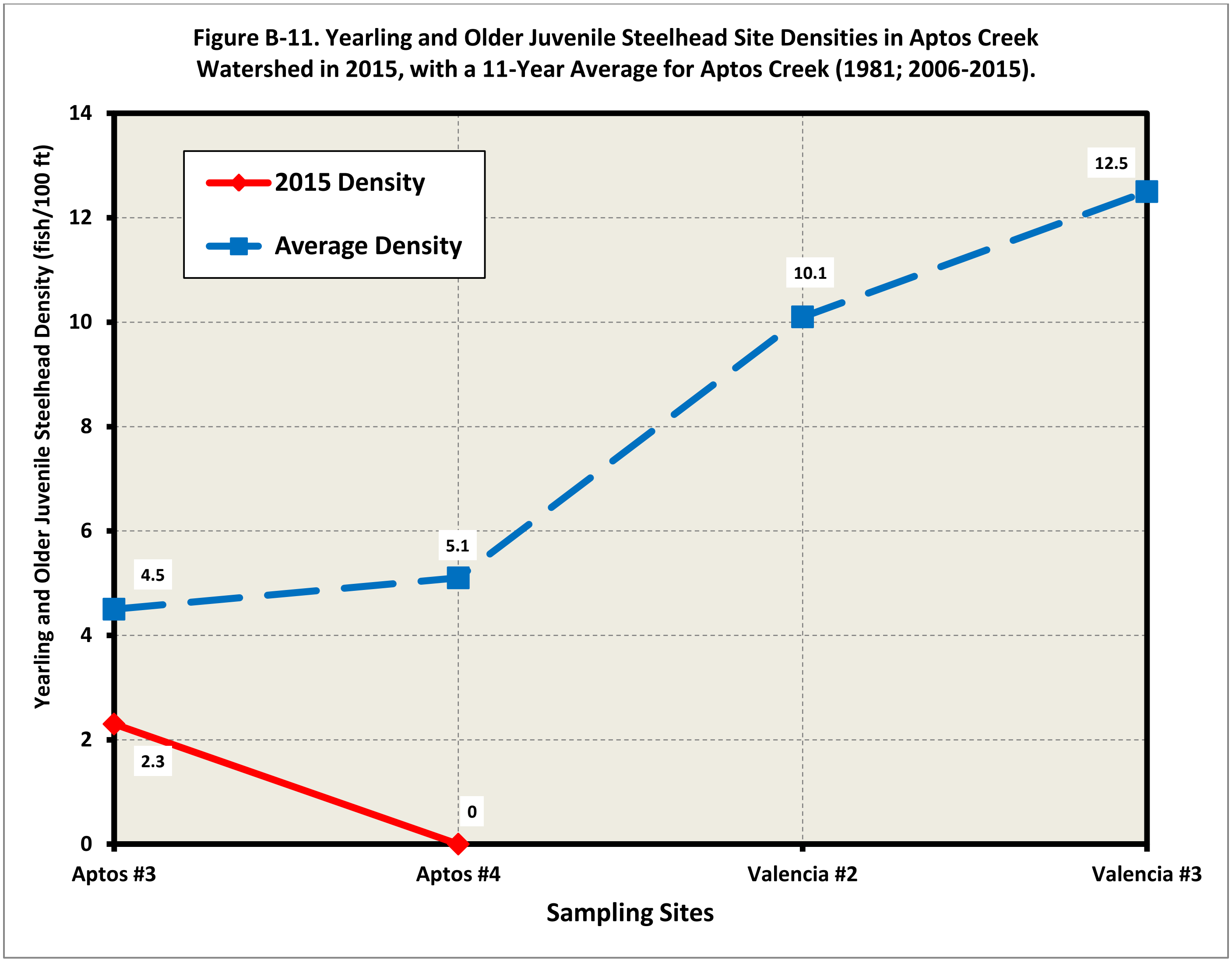

Figure B-11. Yearling and Older Juvenile Steelhead Site Densities in Aptos Creek in 2015, with an 11-Year Average (1981; 2006-2015).

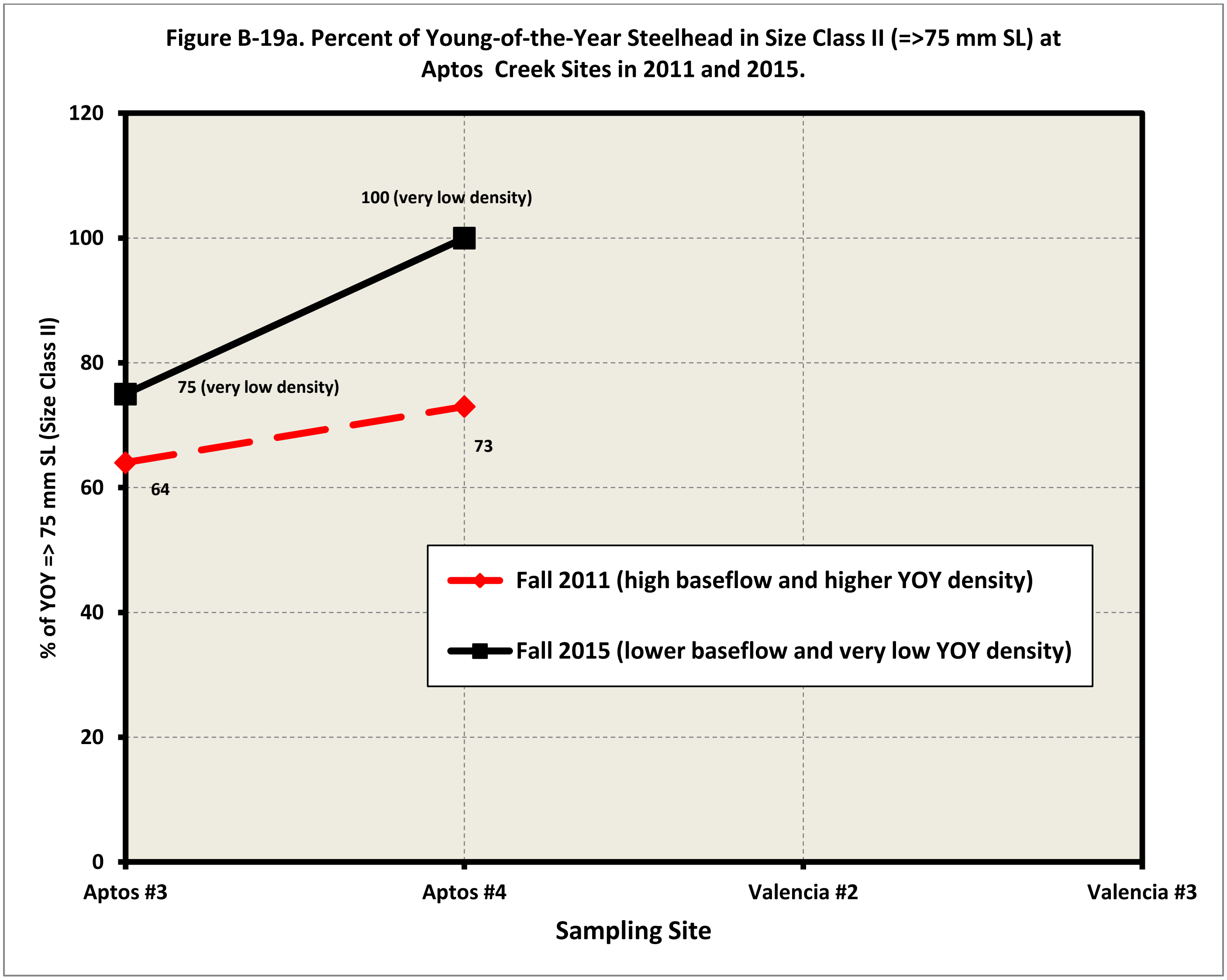

Figure B-19a. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Aptos Creek Sites in 2011 and 2015.

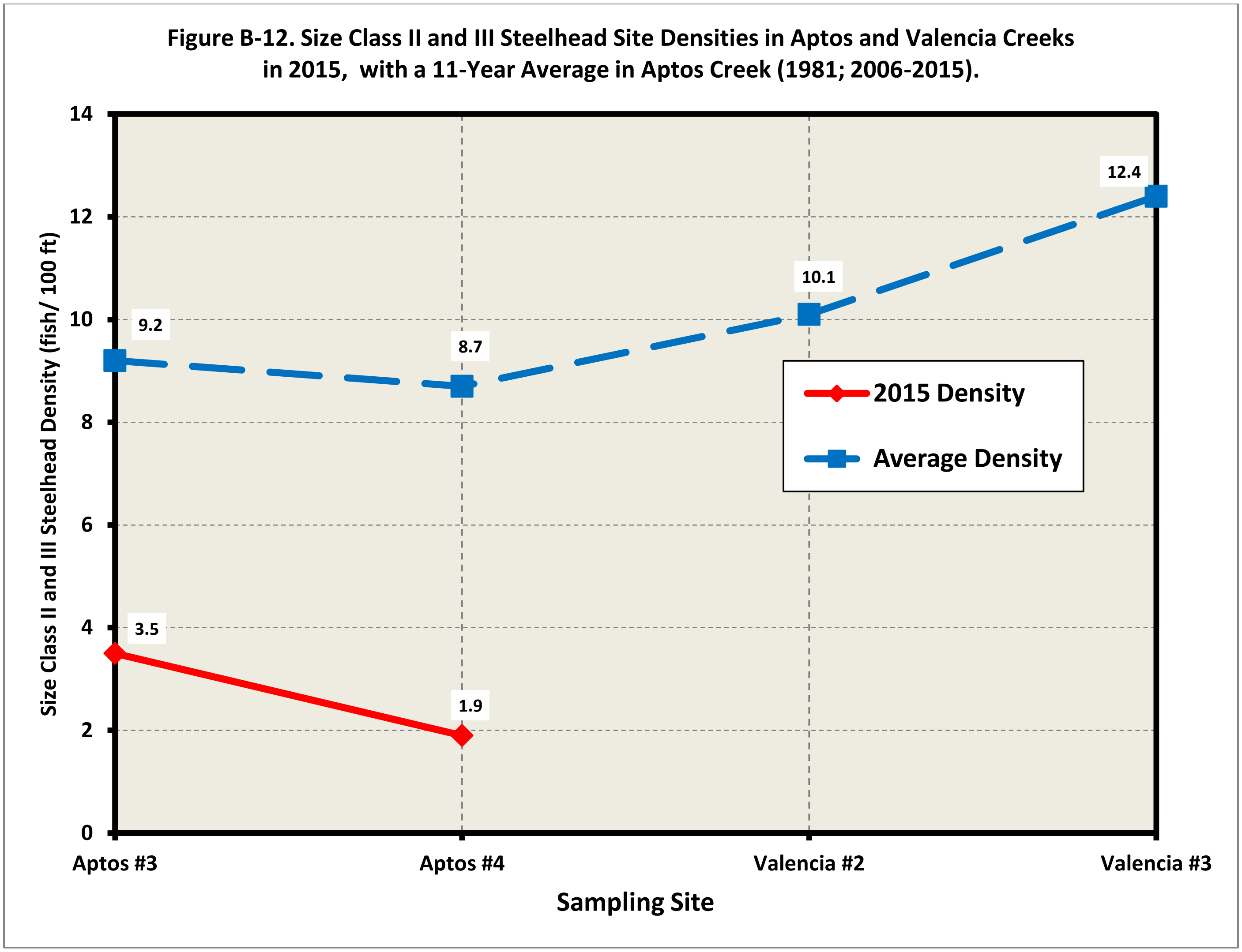

Figure B-12. Size Class II and III Steelhead Site Densities in Aptos and Valencia Creeks in 2015, with an 11-Year Average (1981; 2006-2015).

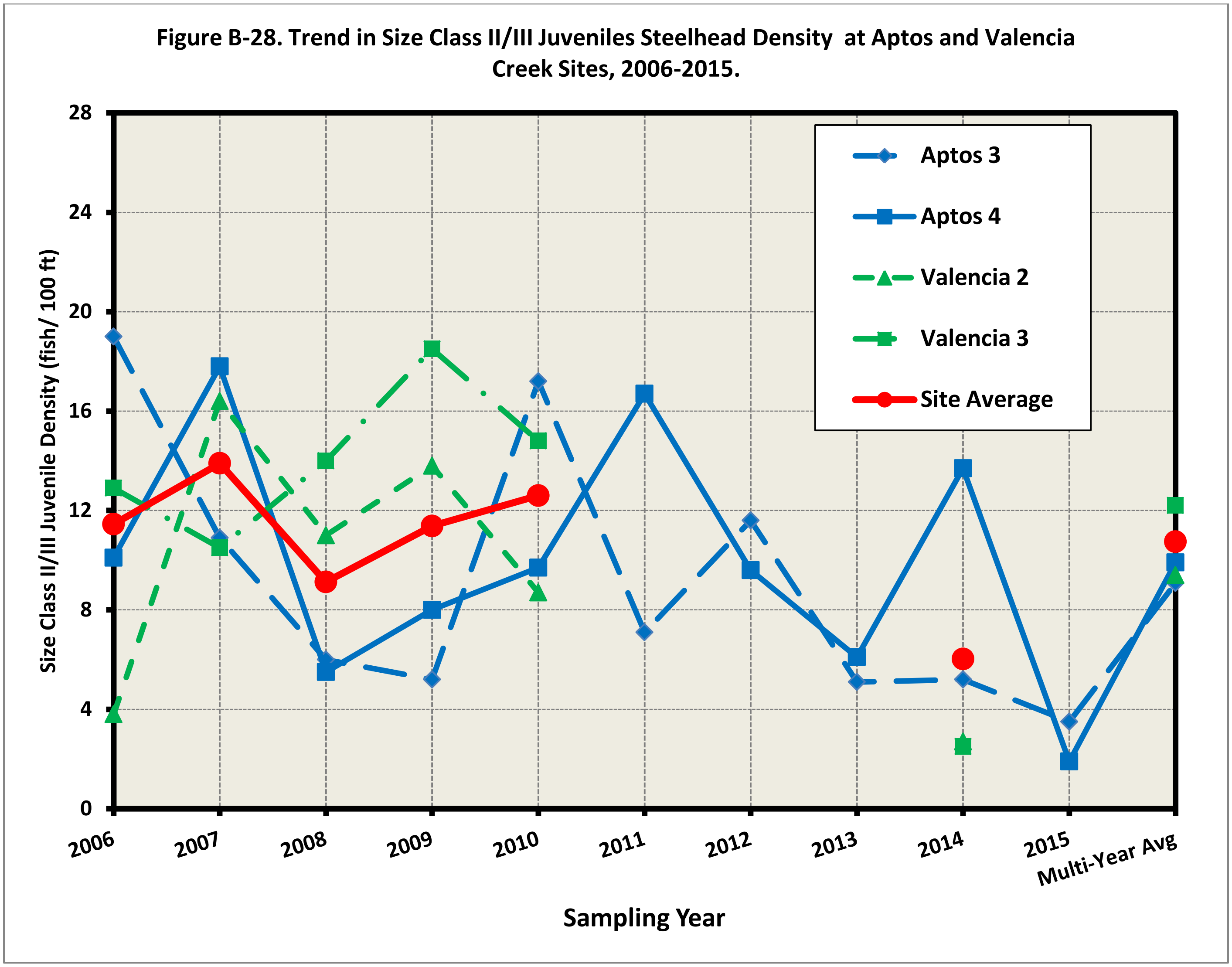

Figure B-28. Trend in Size Class II/III Juveniles Steelhead Density at Aptos and Valencia Creek Sites, 2006-2015.

v. Steelhead Abundance and Habitat in the Corralitos Creek Sub-Watershed

1. Overall habitat quality improved at repeated sites in 2015 compared to 2014 but declined in reaches that were compared to 2012 and 2013 conditions. Improvement at sites occurred from likely higher baseflow early in the dry season with slightly less than 2014 at the end at most sites, increased pool depth at all sites and increased escape cover at some sites (***Tables S-3** below, **Figures B-43a-b** below **and B-16c** above **and Tables 5b and 16a-b in Appendix B***). Percent fines and embeddedness remained similar to previous years' comparisons of sites and reaches. Reach 1 below the dam had more fine sediment, less escape cover and presumed less streamflow to bring an overall negative habitat change from 2013 conditions. Reach 5/6 had reduced streamflow, pool depth and escape cover compared to 2012 conditions, resulting in overall negative habitat change and no recovery since 2012 from sedimentation occurring after the 2008 summit fire.

2. In 2015, ***total juvenile densities*** followed the same pattern as YOY densities compared to 2014 and to long term average densities (***Table 31 in Appendix B; Figure B-13** below*). Increased total juvenile densities from 2014 to 2015 were statistically significant (***Table 47 in Appendix B***). Total densities were below average at 5 of 6 sites but higher than in 2014 at all of them. The trend in total densities for the 6 Corralitos and Browns creek sites increased from 2014 but was still the third lowest in 12 years of monitoring (***Figure B-29** below*).

3. In 2015, ***YOY densities*** were not as low as in 2014 but still below average at 5 of 6 sites (except the site downstream of the Corralitos diversion dam) (***Table 32 in Appendix B; Figure B-14** below*). The increase from 2014 to 2015 was statistically significant (***Table 47 in Appendix B***). This indicated either better adult spawning access or more spawners in 2015 than 2014. The upper Browns Creek site had the highest YOY density (30.9 YOY/ 100 ft) in 2015, as was the case in 2014.

4. In 2015, ***yearling densities*** varied between 2.2 and 5.4 fish/ 100 feet (***Table 33 in Appendix B***). Yearling densities were less than in 2014 at 4 of 6 sites, with so few YOY present in 2014 to be recruited (decrease not statistically significant (***Table 47 in Appendix B***)). 2015 yearling densities were below average at all 6 sites (***Figure B-15** below*).

5. In 2015, ***Size Class II densities*** were less than those in 2014 at all 6 sites (decrease statistically significant (***Tables 35 and 47 in Appendix B***)). Densities were much below average at all 6 sites (***Figure B-16** below*). The trend in soon-to-smolt densities had declined since 2012 (***Figure B-32** below*). The 4-site average in Corralitos Creek by itself was the lowest since 2007 (4.1 fish/ 100 ft) (***Figure B-31** below*). The 6-site average in 2015 for both Corralitos and Browns creeks (4.4 fish/ 100 ft) was the lowest compared to past years of 8-site averages in 12 years of monitoring. The highest density of soon-to-smolt fish in 2015 was at Browns 2 above the dam (5.4 fish/ 100 ft).

Below average densities of yearlings at all sites, along with the small number of YOY reaching Size Class II (low baseflow (***Table 5b in Appendix B***), lead to relatively low densities of the larger fish compared to previous years. The much below average densities of Size Class II consisting of few yearlings and a preponderance of YOY (at below average densities) that could not reach Size Class II were consistent with lower baseflow, limited spawning success and reduced habitat quality overall. Only 1% of YOY reached soon-to-smolt size at Site 1 and none reached it at the other 5 sites, compared to much higher percentages in a wetter year like 2011 (***Figure B-20a*** *below*).

6. Sampling site ratings based on soon-to-smolt densities declined at 1 site in 2015 compared to 2014 (Corralitos Site 1 went from “fair” to “poor”) and improved at one site (Browns Site 2 went from “below average” to “fair”) (***Table S-3*** *below*). The Corralitos sub-watershed had relatively higher ratings than the other 3 sampled watersheds, with 4 of 6 sites rated as “fair.”

7. For the Corralitos sub-watershed, the abundance indices for Size Class II and III juveniles for 6 reaches (excluding Shinglemill Gulch) were 3,000 in 2010, 2,000 in 2014 and 1,000 in 2015 (***Figures B-35a and B-35b*** *below*). The reach index total in 2015 was only one third the 2010 index. Since it is this size class of juveniles that will soon smolt and contribute most to adult returns, the difference in potential smolt production between a more typical year, 2010 with slightly above median baseflow, and dry years was substantial. The two-thirds decline was due to virtually no YOY reaching Size Class II in 2015, and reach indices consisted of yearlings at below average densities. In 2010, these soon-to-smolt fish consisted of both fast growing YOY (25−85% of YOY reaching Size Class II and yearlings.

vi. Steelhead and Tidewater Goby Abundance and Habitat in the Pajaro River Lagoon

No steelhead were captured during sampling of Pajaro Lagoon in early October, though water quality conditions in the lower lagoon adjacent to the beach were unstratified and not prohibitive for the species. However, oxygen was sharply stratified upstream of the beach in the leveed section, with oxygen declining quickly at depth to the bottom, even on sunny afternoons. This indicated a very high biological oxygen demand. Tidewater goby were present in the leveed section but less abundant than previous years. No tidewater gobies were detected along the beachfront, where algae and submerged vegetation was lacking. ***Refer to Appendix B for methods, species tables (36−38) and water quality tables (39 and 40).*** A new species, striped mullet, was captured in the upper lagoon in good numbers. Smelt were the most common fishes in the lower lagoon. The sandbar had remained open until March 31, after which it opened and closed for several day periods until final seasonal closure occurred between May 6 and June 1. The pattern of sandbar closures excluded most marine species from the lagoon.

Table S-3. 2015 Sampling Sites Rated by Potential Smolt-Sized Juvenile Density (=>75 mm SL) and Average Smolt Size, with Physical Habitat Change since 2014. (Red denotes ratings of 1−3 or negative habitat change; purple denotes ratings of 5−7. Methods for assessing habitat change in M-6 of **Appendix B**).

Site	Multi-Year Avg. Potential Smolt Density Per 100 ft	2015 Potential Smolt Density (per 100 ft)/ Avg Pot. Smolt Size SL	2015 Numeric Smolt Rating (With Size Factored In)	2015 Symbolic Rating (1 to 7)	Physical Habitat Change by Reach/Site Since 2014
Low. San Lorenzo #0a	9.0	4.8/ 83 mm	2 (Poor)	@@	Site Positive
Low. San Lorenzo #1	7.0	4.4/ 95 mm	3 (Below Avg)	@@@	Site Positive
Low. San Lorenzo #2	13.5	3.5/ 90 mm	2	@@	Reach Positive
Low. San Lorenzo #4	13.2	2.6/ 80 mm	1 (Very Poor)	@	Reach Negative
Mid. San Lorenzo #6	4.0	0.5/ 75 mm	1	@	Site Positive
Mid. San Lorenzo #8	5.6	0/ 0 mm	1	@	Site Positive
Mid. San Lorenzo #9	6.6	1.3/ 83 mm	1	@	Site Positive
Up. San Lorenzo #10	5.1	1.4/ 82 mm	1	@	Site Positive
Up. San Lorenzo #11	6.0	5.8/ 98 mm	3	@@@	Site Positive
Up.San Loren #12a (res.Rt)	8.0	6.8/ 97 mm	3	@@@	NA
Zayante #13a	9.4	2.1/ 86 mm	1	@	Site Positive
Zayante #13c	15.2	44.7/ 87 mm	5 (Good)	@@@@@	Site Positive
Zayante #13d	15.7	8.3/ 97 mm	4 (Fair)	@@@@	Site Positive
Lompico #13e	6.9	6.8/ 93 mm	3	@@@	Site Negative
Zayante #13i	7.4	7.4/ 112 mm	4	@@@@	NA
Bean #14a	4.2	1.4/ 90 mm	1	@	NA
Bean #14b	12.0	11.5/ 104 mm	5	@@@@@	Reach Positive
Bean #14c	7.8	Dry	Dry	Dry	Dry
Fall #15a	4.4	6.0/ 99 mm	3	@@@	Site Positive
Fall #15b	12.6	6.7/ 95 mm	3	@@@	Site Positive
Newell #16	13.0	2.0/ 86 mm	1	@	Site Negative
Boulder #17a	10.3	1.0/ 106 mm	2	@@	Site Positive
Boulder #17b	10.5	5.7/ 88 mm	2	@@	Site Negative
Bear #18a	9.4	1.0/ 76 mm	1	@	Site Positive
Branciforte #21b	13.1	6.8/ 103 mm	4	@@@@	Site Negative
Branciforte #21c (res. Rt)	9.8	6.2/ 115 mm	4	@@@@	Site Negative
Soquel #1	3.7	2.4/ 101 mm	2	@@	Site Negative
Soquel #4	8.3	0.9/ 79 mm	1	@	Reach Negative
Soquel #10	8.2	0.5/ 76 mm	1	@	Site Positive
Soquel #12	7.5	2.9/ 82 mm	1	@	Reach Negative
East Branch Soquel #13a	10.6	9.1/ 91 mm	4	@@@@	Site Negative
East Branch Soquel #16	9.2	Dry	Dry	Dry	Dry
West Branch Soquel #19	6.0	4.4/ 101 mm	3	@@@	Reach Negative
West Branch Soquel #21	9.6	1.6/ 92 mm	1	@	Site Negative
Aptos #3	9.2	3.5/ 112 mm	3	@@@	Site Positive
Aptos #4	8.7	1.9/ 109 mm	2	@@	Site Positive
Corralitos #1	9.1	5.0/ 85 mm	2	@@	Reach Negative
Corralitos #3	10.4	4.0/ 126 mm	4	@@@@	Site Positive
Corralitos #8	10.2	2.2/ 105 mm	3	@@@	Reach Negative
Corralitos #9	15.9	5.0/ 108 mm	4	@@@@	Site Positive
Browns #1	14.4	4.8/ 126 mm	4	@@@@	Site Positive
Browns #2	12.3	5.4/ 106 mm	4	@@@@	Site Positive

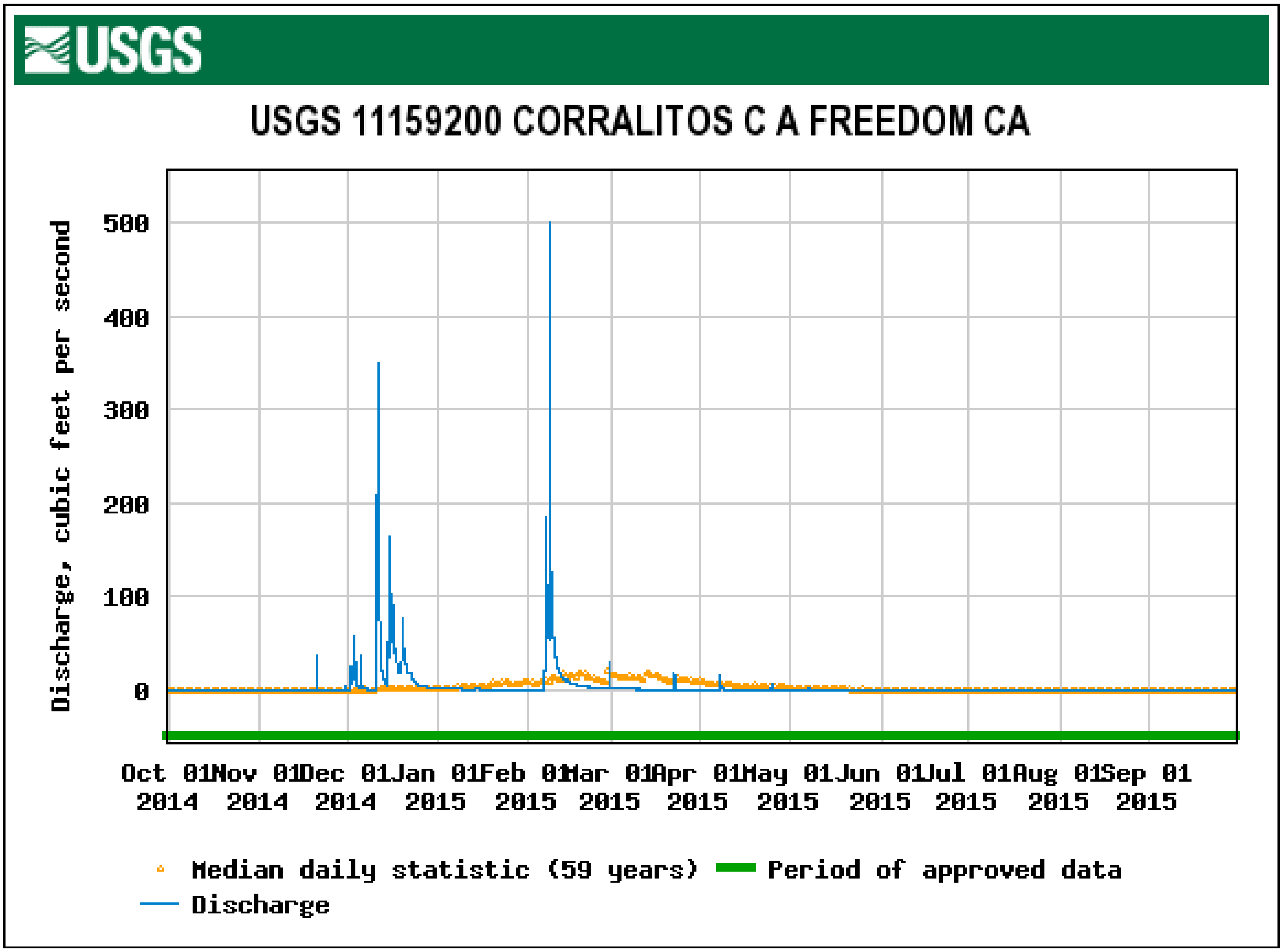

Figure B-42a. The 2015 Discharge at the USGS Gage on Corralitos Creek at Freedom. (USGS website would not provide a logarithmic scale of discharge).

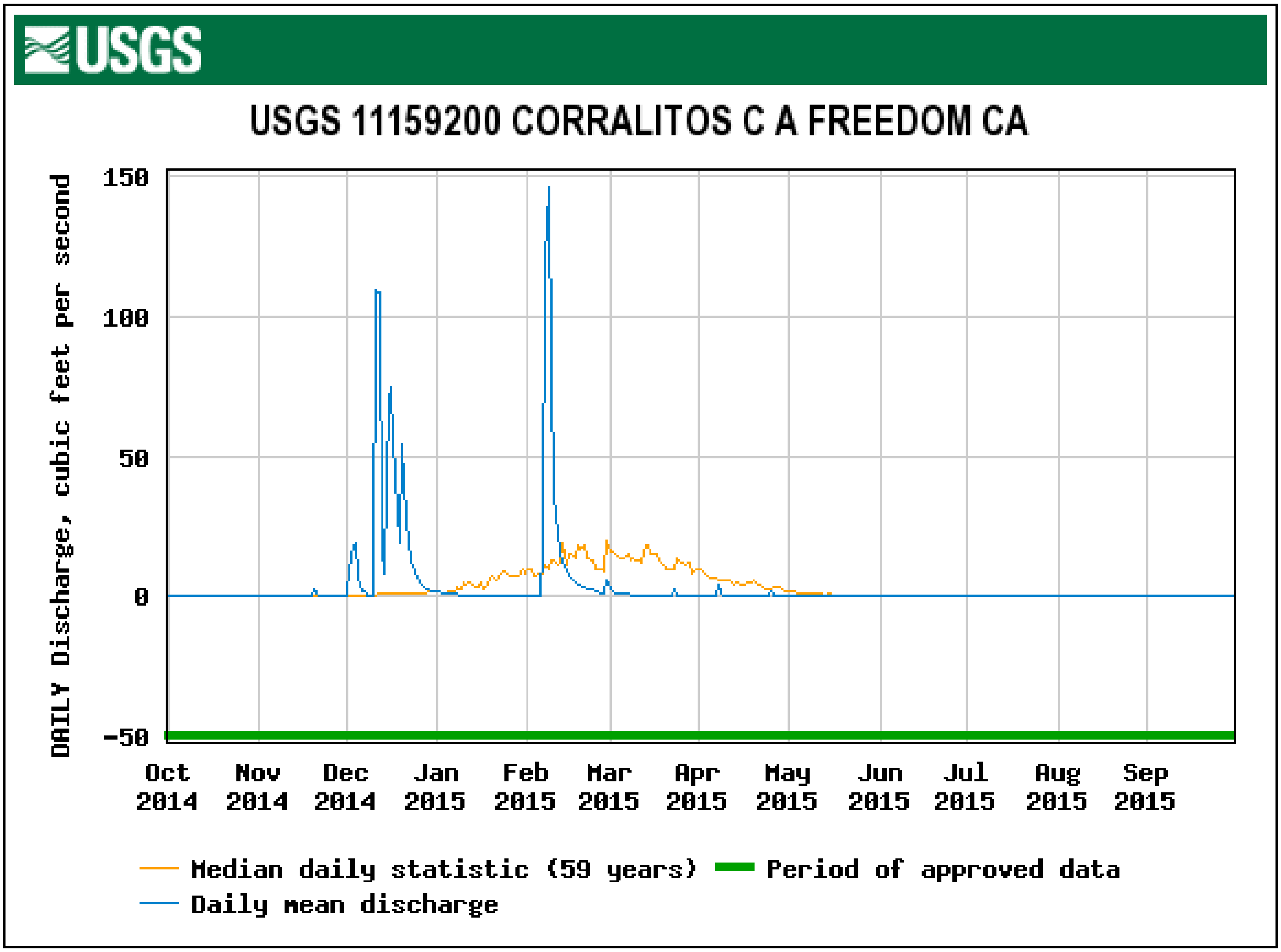

Figure B-42b. The 2015 Daily Mean and Median Flow at the USGS Gage on Corralitos Creek at Freedom. (USGS website would not provide a logarithmic scale of discharge).

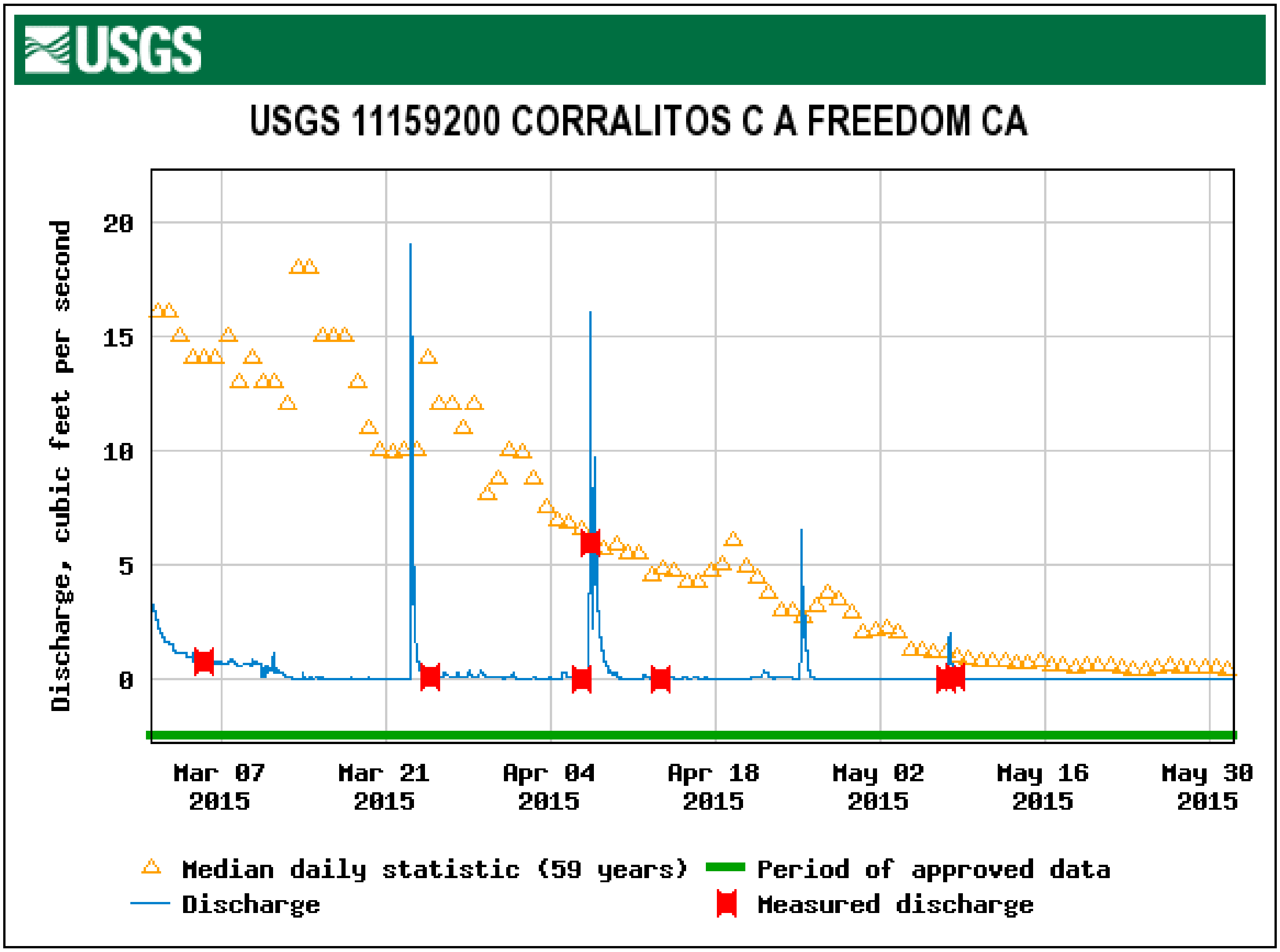

Figure B-42c. The March−May 2015 Discharge of Record for the USGS Gage on Corralitos Creek at Freedom.

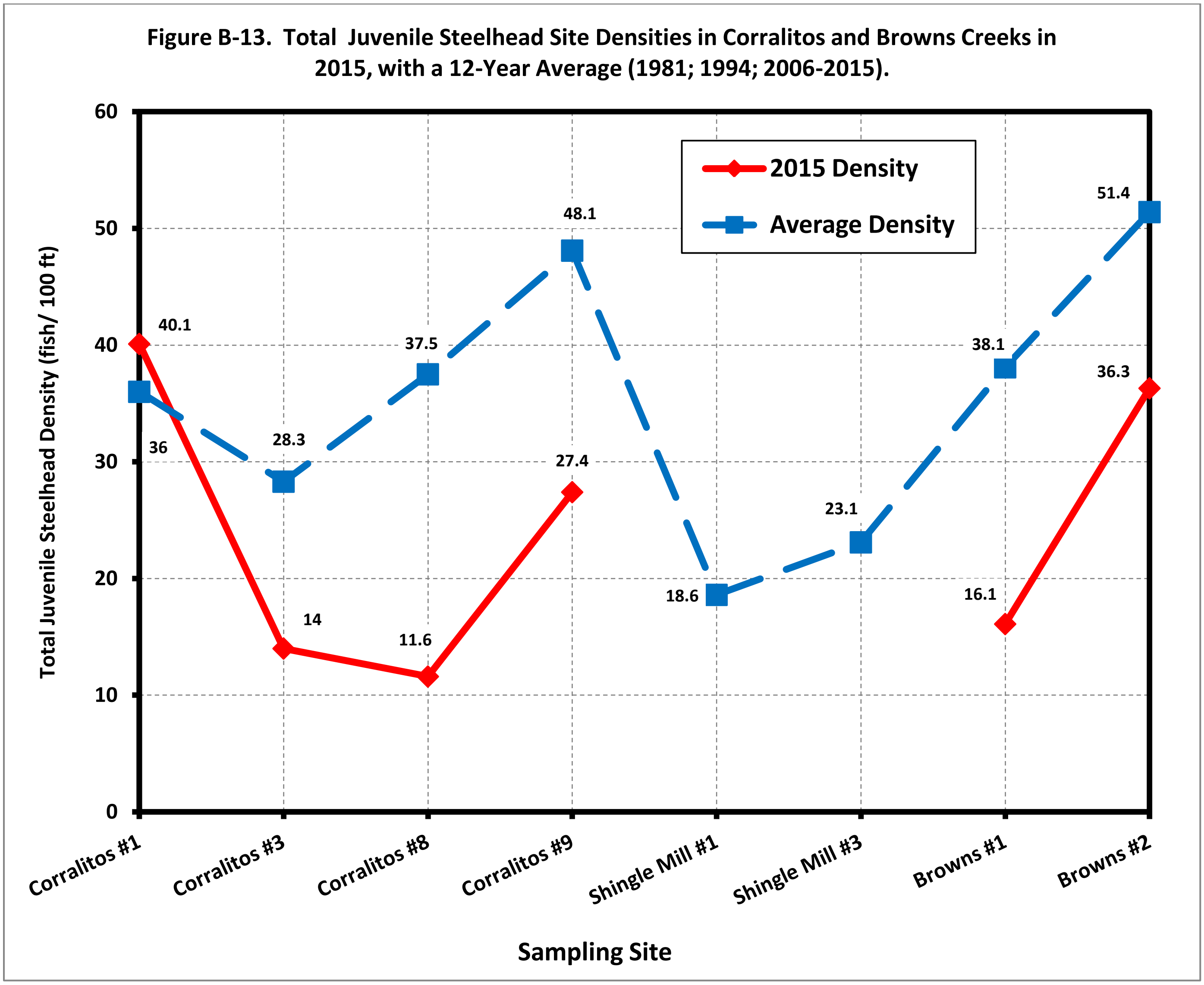

Figure B-13. Total Juvenile Steelhead Site Densities in Corralitos and Browns Creeks in 2015, with a 12-Year Average (1981; 1994; 2006-2015).

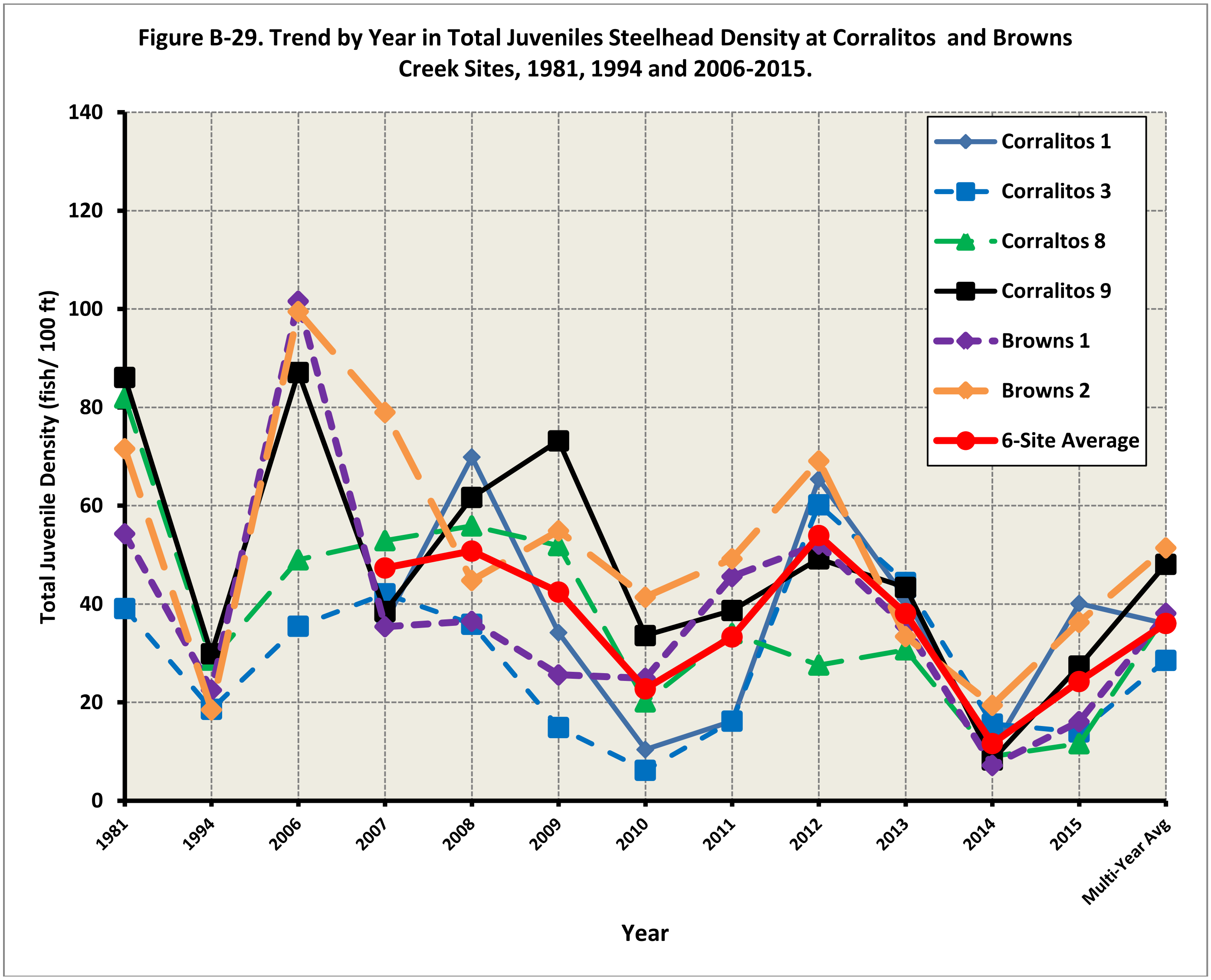

Figure B-29. Trend by Year in Total Juveniles Steelhead Density at Corralitos and Browns Creek Sites, 1981, 1994 and 2006-2015.

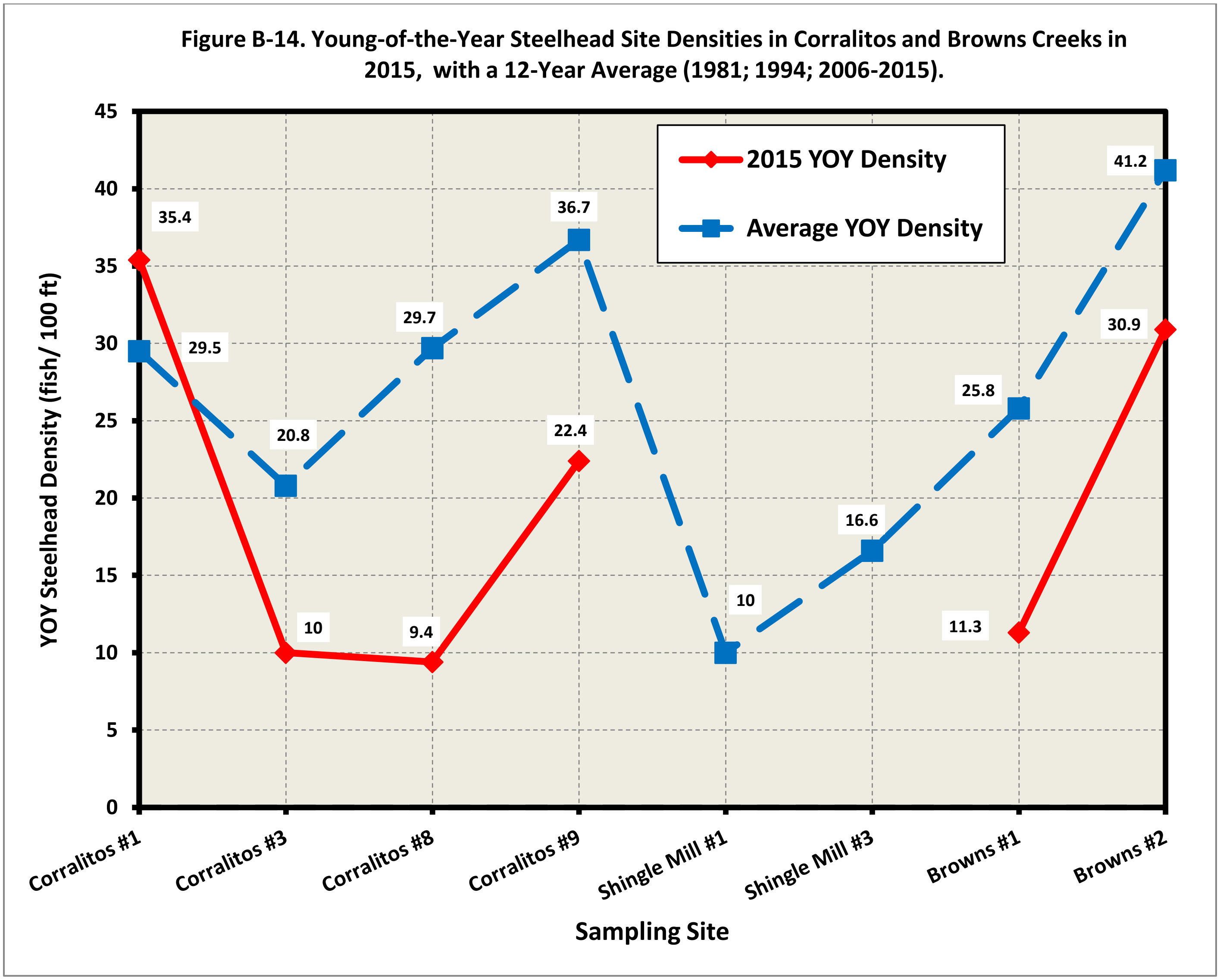

Figure B-14. Young-of-the-Year Steelhead Site Densities in Corralitos and Browns Creeks in 2015, with a 12-Year Average (1981; 1994; 2006-2015).

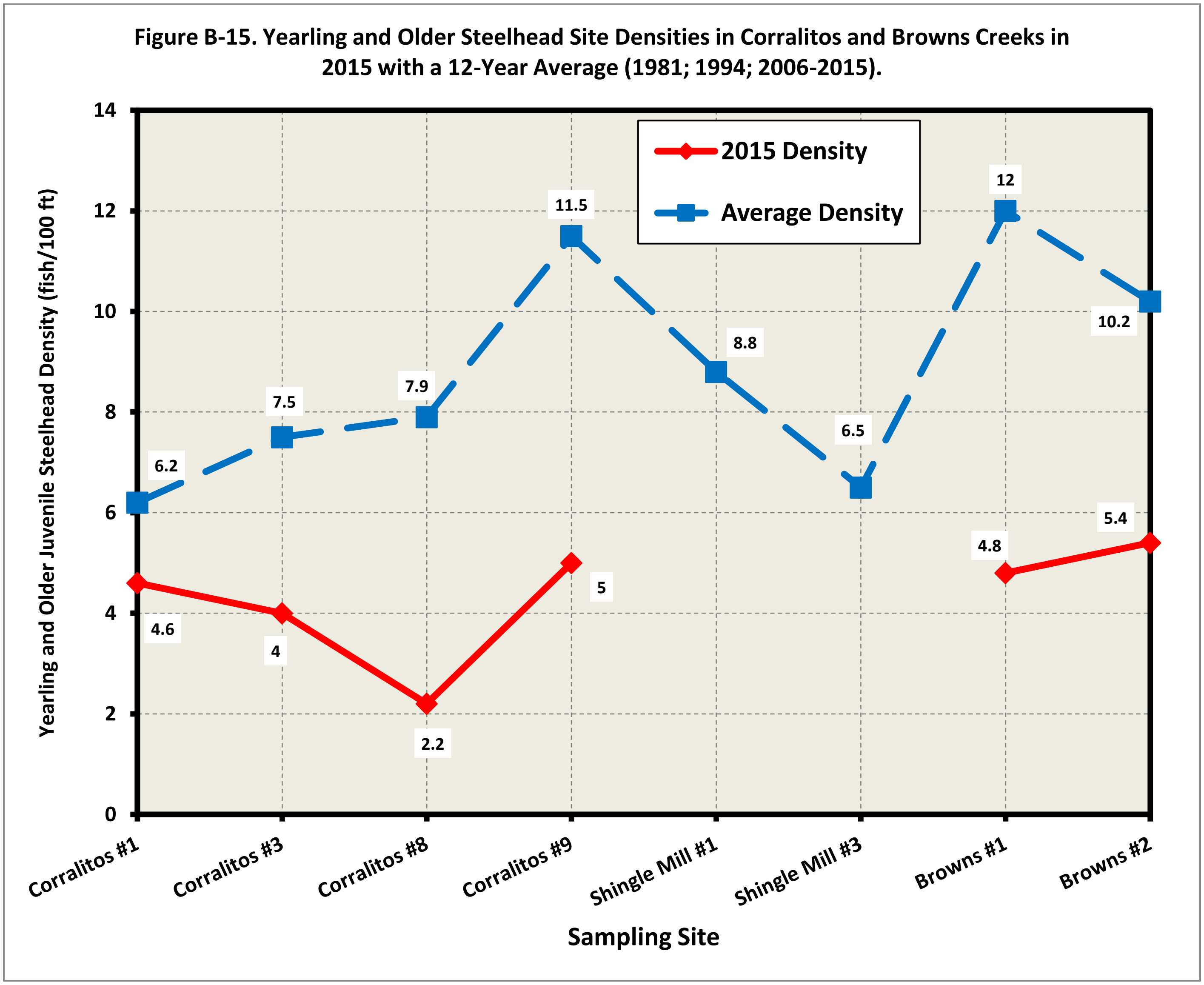

Figure B-15. Yearling and Older Steelhead Site Densities in Corralitos and Browns Creeks in 2015 with a 12-Year Average (1981; 1994; 2006-2015).

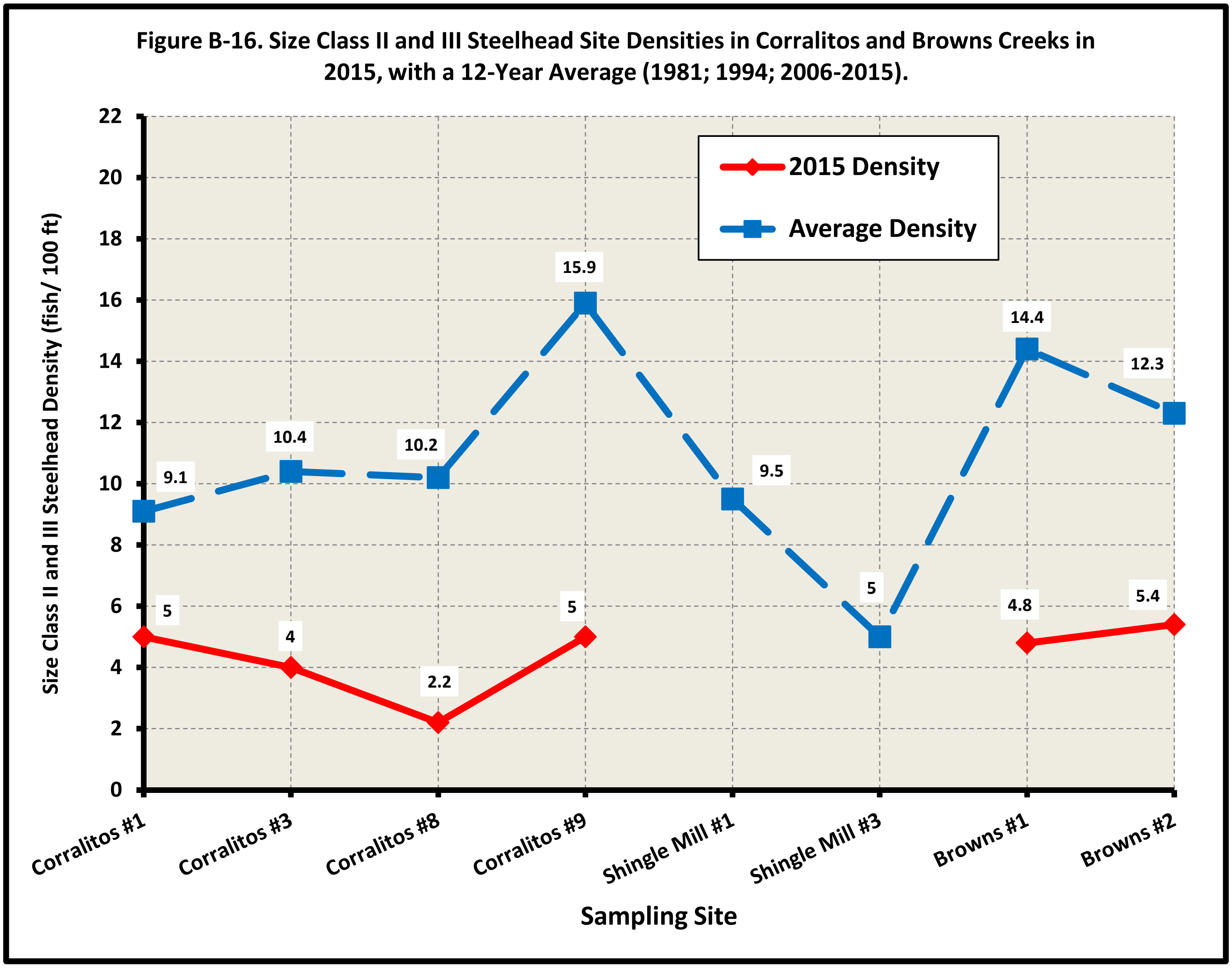

Figure B-16. Size Class II and III Steelhead Site Densities in Corralitos and Browns Creeks in 2015, with a 12-Year Average (1981; 1994; 2006-2015).

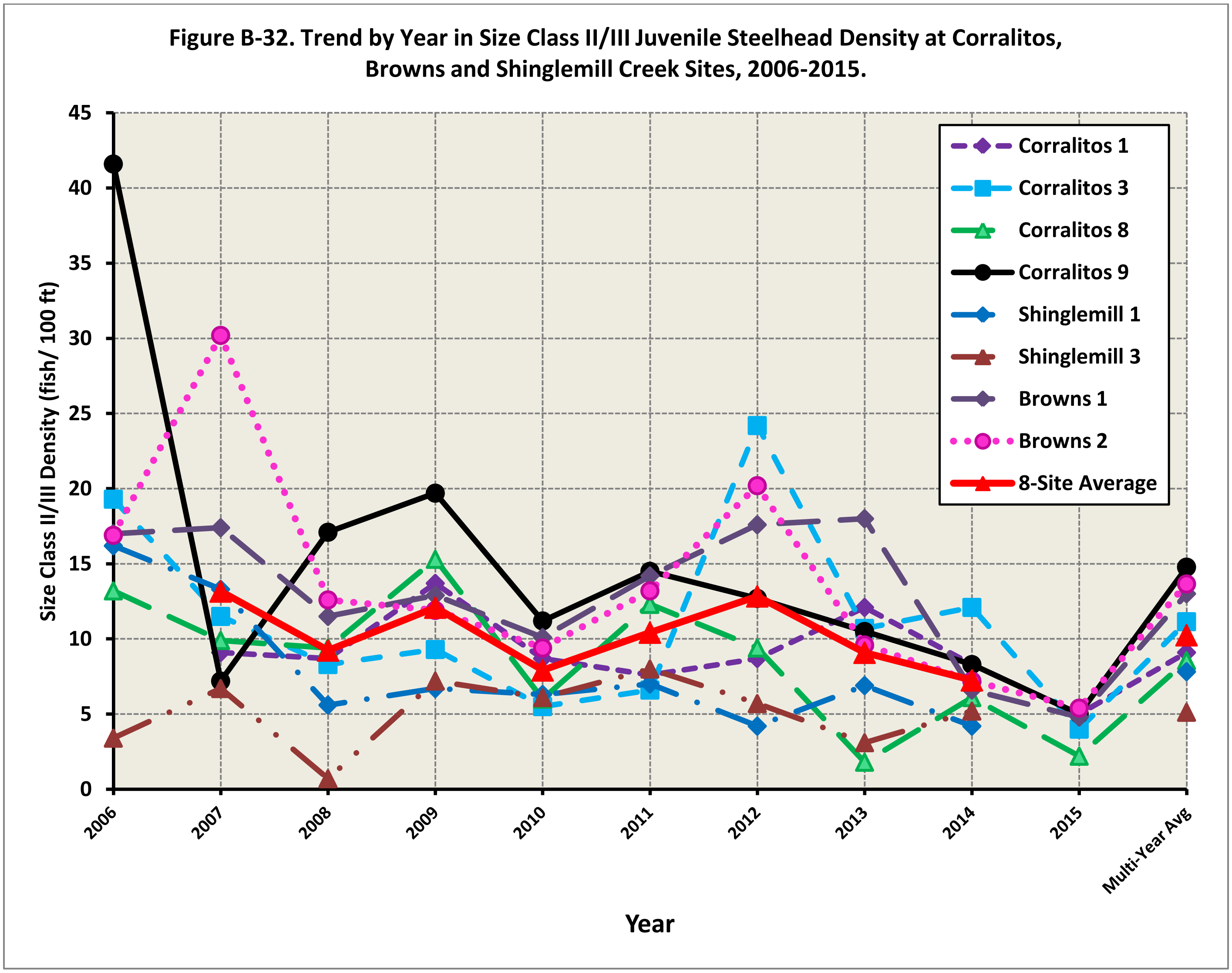

Figure B-32. Trend by Year in Size Class II/III Juveniles Steelhead Density at Corralitos Sub-Watershed Sites, 2006-2015.

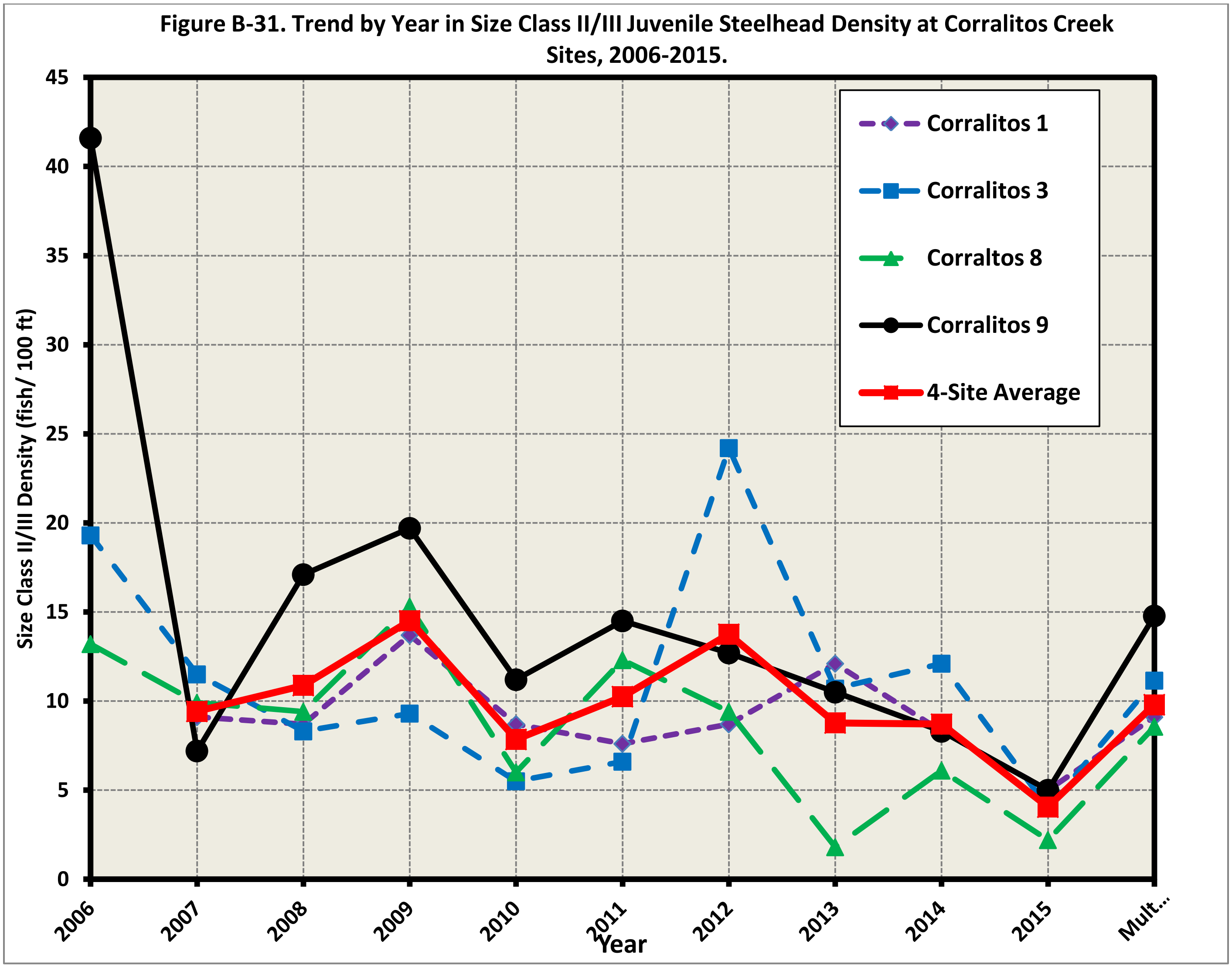

Figure B-31. Trend by Year in Size Class II/III Juveniles Steelhead Density at Corralitos Creek Sites, 2006-2015.

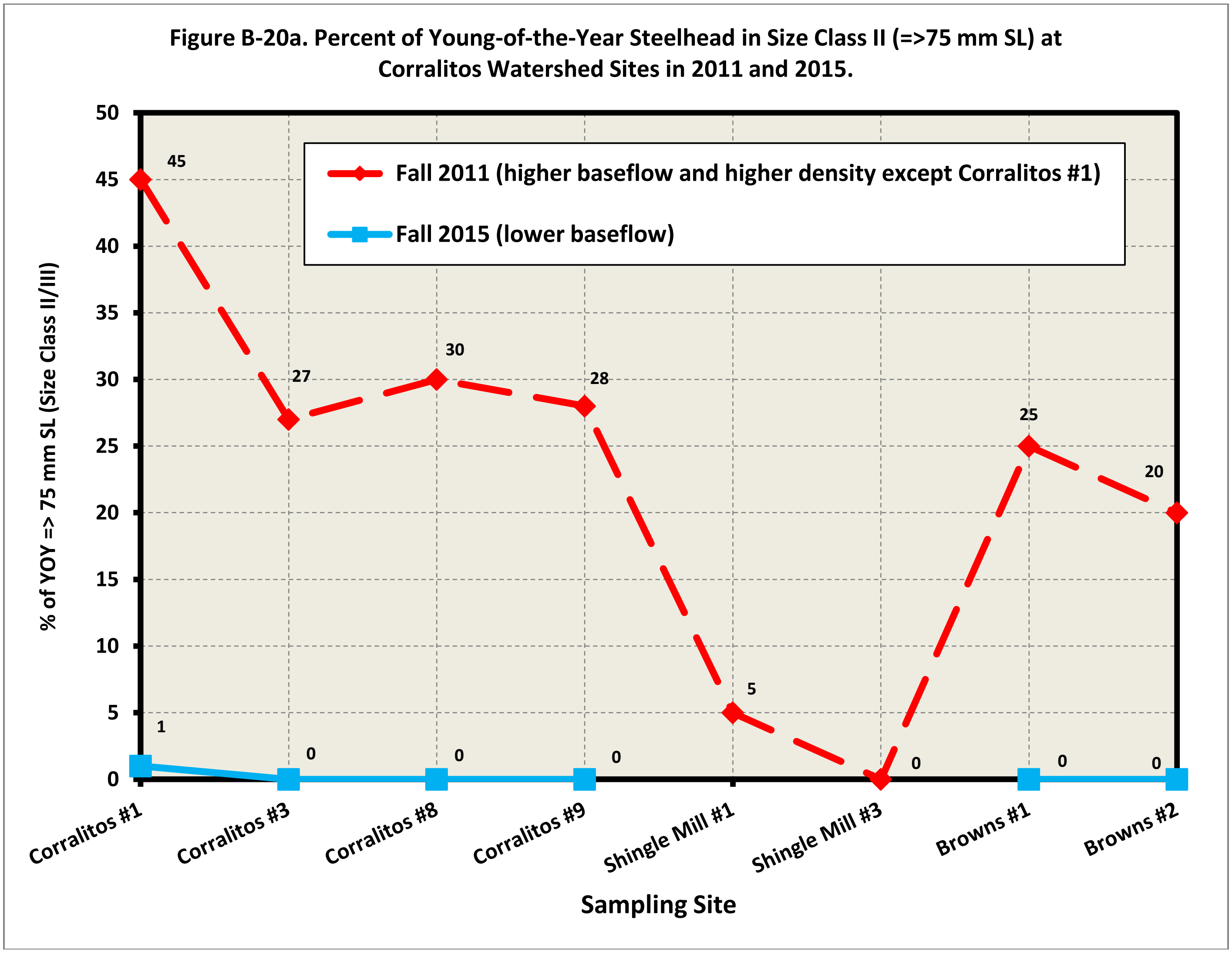

Figure B-20a. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Corralitos Sub-Watershed Sites in 2011 and 2015.

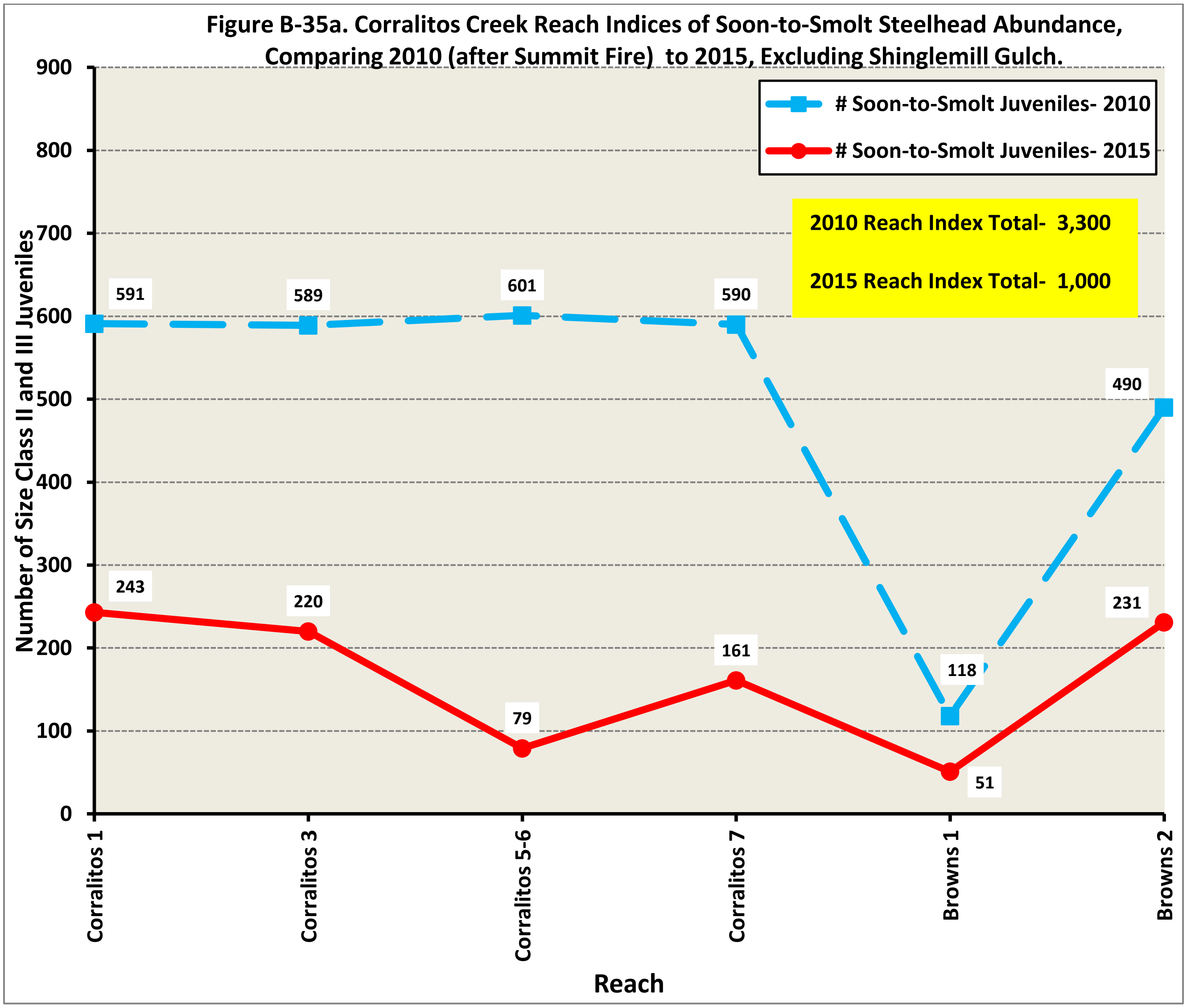

Figure B-35a. Corralitos Creek Reach Indices of Soon-to-Smolt Steelhead Abundance, Comparing 2010 to 2015.

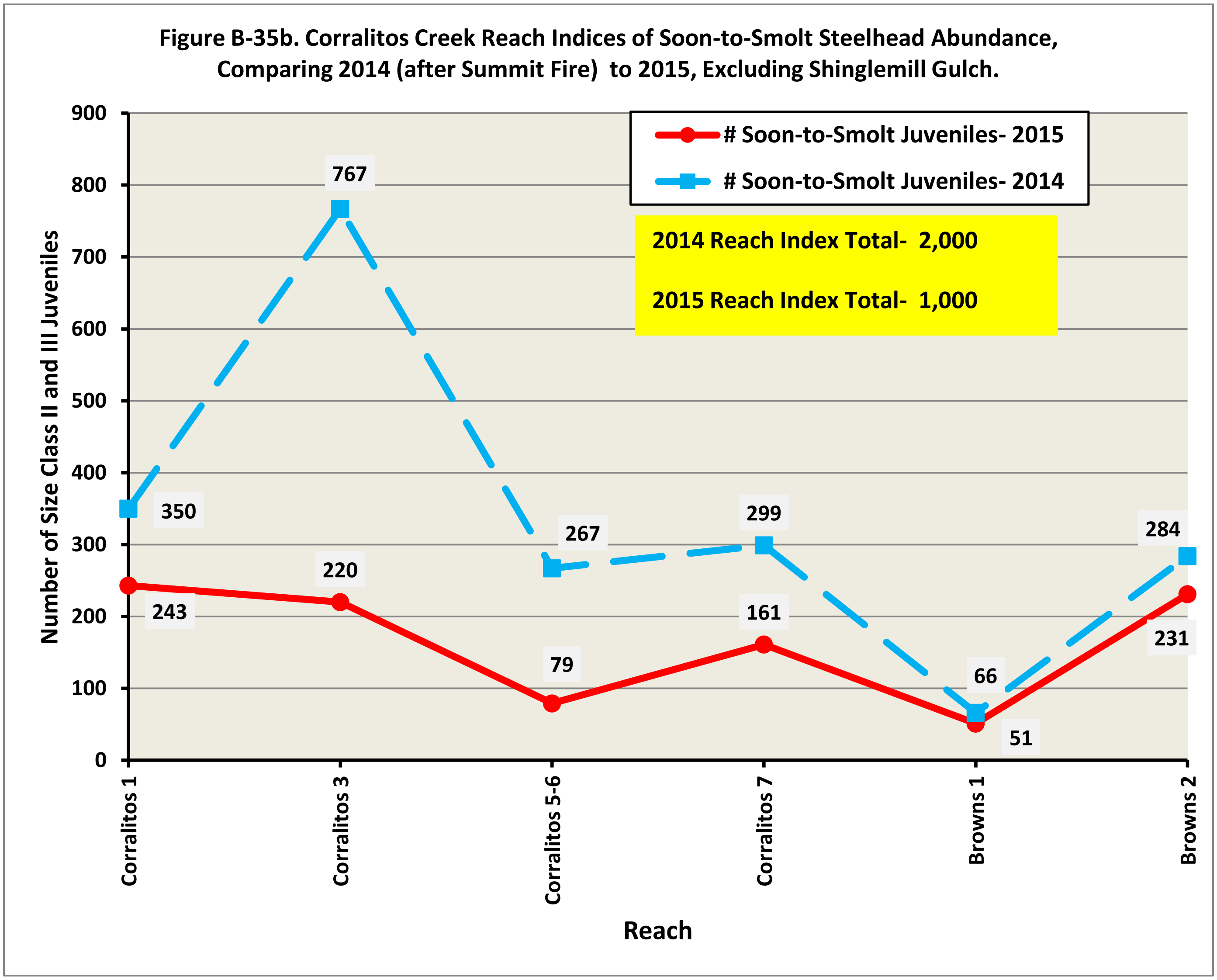

Figure B-35b. Corralitos Creek Reach Indices of Soon-to-Smolt Steelhead Abundance, Comparing 2014 to 2015.

Table B-42. 2015 Sampling Sites Rated by Potential Smolt-Sized Juvenile Density (=>75 mm SL) and Their Average Size in Standard Length Compared to 2014, with Physical Habitat Change Since 2014 Conditions. (Red denotes ratings of 1−3 (as in Table S-3) and negative habitat change and purple denotes ratings of 5−7.

Site	2014 Potential Smolt Density (per 100 ft)/ Avg Pot. Smolt Size SL	2014 Smolt Rating (With Size Factored In)	2015 Potential Smolt Density (per 100 ft)/ Avg Pot. Smolt Size SL	2015 Smolt Rating (With Size Factored In)	Physical Habitat Change by Reach/Site Since 2014
Low. San Lorenzo #0a	6.2/ 108 mm	Fair	4.8/ 83 mm	Poor	+
Low. San Lorenzo #1	1.8/ 125 mm	Poor	4.4/ 95 mm	Below Average	+
Low. San Lorenzo #2	2.4/ 98 mm	Poor	3.5/ 90 mm	Poor	+
Low. San Lorenzo #4	4.4/ 89 mm	Below Average	2.6/ 80 mm	Very Poor	–
Mid. San Lorenzo #6	1.4/ 80 mm	Very Poor	0.5/ 75 mm	Very Poor	+
Mid. San Lorenzo #8	1.4/ 92 mm	Very Poor	0/ 0 mm	Very Poor	+
Mid. San Lorenzo #9	0.6/ 92 mm	Very Poor	1.3/ 83 mm	Very Poor	+
Up. San Lorenzo #10	None	Very Poor	1.4/ 82 mm	Very Poor	+
Up. San Lorenzo #11	1.6/ 112 mm	Poor	5.8/ 98 mm	Below Average	+
Up.San Loren #12a (res. rt)		Not Sampled	6.8/ 97 mm	Below Average	NA
Zayante #13a	2.4/ 89 mm	Poor	2.1/ 86 mm	Very Poor	+ (Cover)
Zayante #13c	3.7/ 81 mm	Very Poor	44.7/ 87 mm	*Good*	+ (Cover)
Zayante #13d	22.1/ 93 mm	*Good*	8.3/ 97 mm	Fair	+ (Cover)
Lompico #13e	6.7/ 94 mm	Below Average	6.8/ 93 mm	Below Average	NA
Zayante #13i	Not Sampled	Not Sampled	7.4/ 112 mm	Fair	NA
Bean #14a	Not Sampled	Not Sampled	1.4/ 90 mm	Very Poor	NA
Bean #14b	2.8/ 101 mm	Poor	11.5/ 104 mm	*Good*	+
Fall #15a	2.7/ 103 mm	Below Average	6.0/ 99 mm	Below Average	+
Fall #15b	7.3/ 103 mm	Fair	6.7/ 95 mm	Below Average	+
Newell #16	3.1/ 109 mm	Below Average	2.0/ 86 mm	Very Poor	–
Boulder #17a	3.8/ 91 mm	Poor	1.0/ 106 mm	Poor	+
Boulder #17b	13.0/ 90 mm	Fair	5.7/ 88 mm	Poor	–
Bear #18a	0.7/ 116 mm	Poor	1.0/ 76 mm	Very Poor	+
Branciforte #21b	7.3/ 98 mm	Below Average	6.8/ 103 mm	Fair	–
Branciforte #21c (res. Rt)	13.3/103 mm	*Good*	6.2/ 115 mm	Fair	–
Soquel #1	0.7/ 102 mm	Very Poor	2.4/ 101 mm	Poor	–
Soquel #4	4.2/ 98 mm	Below Average	0.9/ 79 mm	Very Poor	–
Soquel #10	2.8/ 89 mm	Poor	0.5/ 76 mm	Very Poor	+
Soquel #12	2.8/ 95 mm	Poor	2.9/ 82 mm	Very Poor	–
East Branch Soquel #13a	4.3/ 100 mm	Below Average	9.1/ 91 mm	Fair	–
West Branch Soquel #19	2.4/ 92 mm	Poor	4.4/ 101 mm	Below Average	–
West Branch Soquel #21	4.7/ 87 mm	Poor	1.6/ 92 mm	Very Poor	–
Aptos #3	4.7/ 117 mm	Fair	3.5/ 112 mm	Below Average	+
Aptos #4	4.7/ 95 mm	Below Average	1.9/ 109 mm	Poor	–
Corralitos #1	8.3/ 97 mm	Fair	5.0/ 85 mm	Poor	–
Corralitos #3	12.1/ 95 mm	Fair	4.0/ 126 mm	Fair	+
Corralitos #8	6.1/ 97 mm	Below Average	2.2/ 105 mm	Below Average	–
Corralitos #9	8.3/ 94 mm	Fair	5.0/ 108 mm	Fair	+
Browns #1	6.6/ 106 mm	Fair	4.8/ 126 mm	Fair	+

E. MANAGEMENT RECOMMENDATIONS

1. Implement the fishery-related recommendations and projects identified in the Soquel Creek Watershed Assessment and Enhancement Project Plan, especially in Appendix C (**SCRCD 2003**). High priority would be improvement of adult steelhead passage at Girl Scout Falls II on the West Branch to allow steelhead passage to 4 additional miles of habitat on a regular basis. Another would be to restore the redwood/Douglas Fir forest within and outside the riparian corridor, upstream of Moores Gulch, to cool water temperatures for coho re-introduction.

2. In Soquel Creek, develop better water management and conservation, with the goal of reducing spring and early summer water diversion/pumpage and maximizing baseflow. Much of East Branch Soquel went dry in 2014. Educational outreach to capture and store more winter rains should be directed to streamside landowners, quarry owners, agriculturalists and nursery owners to maintain surface flow and increase baseflow. With increased baseflows, steelhead growth rate and densities of soon-to-smolt sized juveniles will likely increase.

3. Perform erosion control at the Highland Way slide on East Branch Soquel Creek to reduce chronic sedimentation from that site that presently degrades spawning and rearing habitat for more than 15 miles downstream to the lagoon.

4. Implement the fishery enhancement projects identified in the San Lorenzo River Salmonid Enhancement Plan (**Alley et al. 2004**). There are multiple low flow passage impediments which may substantially impede or prevent adult salmonid passage in mild winters like 2013 and 2014. Remove or modify fish passage impediments that were identified in the 2004 Plan and those rated as high and moderate priority in surveys performed recently by Santa Cruz County staff (**Kittleson 2015a; 2015b**). If many of the remnant flashboard dam abutments with associated walls and openings collect instream wood in the future, they may become very significant impediments even in wetter winters if they become jammed with wood, as they may have been in the past. Such flashboard dams should be routinely inspected to detect any log jams that may have formed on them during winter/spring stormflows. These low flow impediments may significantly inhibit coho recovery if not addressed, because entire year classes may be weakened if adult access to the watershed is largely prevented when early winter storms are lacking. The cold water refuges required for coho rearing are located in the upper mainstem and tributaries of the upper watershed, where access must be insured. At least 6 impediments that will impede adult salmonid passage during mild winters were present in the lower and middle mainstem San Lorenzo (**Alley et al. 2004**). They included the Rincon riffle, Four Rock boulder field (partially modified), the Huckleberry Island flashboard dam in Brookdale and the Barker's Dam between the Erwin Way bridges (**see photo below**) (**Alley et al. 2004**).

5. Prioritize and remove/modify high and moderate priority adult salmonid passage impediments identified in Reaches 10−12 on the upper mainstem San Lorenzo between the Boulder Creek confluence and Waterman Gap (**Kittleson 2015b**). At least 6 potentially significant impediments

during mild winters were present in the upper mainstem above the Boulder Creek confluence. They included the flashboard dam abutment upstream of the Brimblecom Road Bridge, the collapsed flashboard dam abutment above the Kings Creek confluence, the concrete sill downstream of the Either Way Bridge, the San Lorenzo Woods remnant dam abutment just upstream of the Fern Drive Bridge, the Highway 9 culvert apron in Waterman Gap (**see photo below**) and the Waterman Gap road ford. The juvenile steelhead density at the Teihl Site 11 has been very low for several years, indicating poor adult passage. The same was true for Site 10 below the Kings Creek confluence in 2014. The San Lorenzo salmonid population in Waterman Gap (above the Highway 9 culvert and concrete apron and above the concrete road ford) has the size structure of a typical resident rainbow trout population. Steelhead redds have been observed above Highway 9 in the past (**K. Kittleson pers. observation**).

6. After passage at the Highway 9 culvert is improved, dismantle all log weirs previously constructed in the Waterman Gap 12b reach of the San Lorenzo River, upstream of Highway 9. They inhibit natural scour, reduce fastwater insect habitat, prevent proper flow dynamics for drift feeding by salmonids at heads of pools and have created a passage impediment in at least one location.

7. Remove/modify the remnant flashboard dam on lower Bear Creek. It is located downstream of the Lanktree bridge. Based on results at our Bear Creek 18a sampling site, it appeared to be a total adult steelhead barrier in 2013 and 2014 because it periodically collects instream wood (**see photo below**). At least the walls that create a narrow opening through this dam should be removed.

8. Retain more large, instream wood throughout all four watersheds under study. More instream wood will promote scour, deepen pools, create patches of coarser spawning gravel and provide escape cover for juvenile steelhead rearing and overwinter yearling survival. The goal is to increase steelhead spawning success and juvenile production to at least the level seen in the late 1990's.

9. Retain more winter storm runoff in Scotts Valley and Felton to reduce stormflow flashiness that causes streambank erosion and sedimentation, leading to poor spawning and rearing conditions in the mainstem. Better storm runoff retention will also increase winter recharge of aquifers to increase spring and summer baseflow, which will increase YOY steelhead growth into Size Classes II and III in Bean Creek, Zayante Creek and the lower mainstem.

10. Support efforts to capture high winter stormflows in the San Lorenzo River for conjunctive use among water agencies within the watershed and with the Soquel Creek Water District to rest Scotts Valley groundwater aquifers (Lompico and Santa Margarita) and the Soquel Creek groundwater aquifer. The goal is to increase spring/summer baseflow, steelhead growth rate and densities of soon-to-smolt sized juveniles in both watersheds.

11. The San Lorenzo Lagoon provides important steelhead habitat in the watershed. Support efforts to allow the sandbar to form naturally and to allow sufficient stream inflow to convert the lagoon to freshwater as quickly as possible after sandbar closure.

12. Prevent artificial summertime breaching of the sandbar at the mouth of the San Lorenzo River.

13. Along Bean Creek (tributary to Zayante Creek) and East Branch Soquel Creek, perform educational outreach to promote better water conservation and winter water storage to reduce summer well pumping and water diversion. The goal is to maintain surface streamflow in the heavily used steelhead segment between Ruins and MacKenzie creek confluences, which go dry annually, as well as in the reach between MacKenzie creek confluence and at least the Redwood Glen Camp upstream, which goes dry in drier years.

14. In Fall Creek, notch the fallen old-growth Douglas fir across the channel to improve adult passage. Dislodge the redwood logs previously installed across the stream channel, downstream of the island below the bridge to improve adult steelhead passage.

15. In Lompico Creek, YOY production widely fluctuates, indicating problems with adult passage and spawning success. Investigate passage issues in the lower reaches, including the bedrock cascade above the fish ladder and the abandoned flashboard dam spillway between the ladder and the sampling site. Continue to maintain the fish ladder.

16. In Branciforte Creek, prioritize and remove/modify high and moderate priority man-made adult steelhead passage impediments identified in recent county surveys. Some of the more important ones included the Branciforte flood control channel (**see photo below**), the logjam at De Laveaga Park, the Santa Vida ford, the Happy Valley dam remnant #1, a collapsed bridge, the remnant Santa Cruz diversion dam abutment and the Casa de Montgomery rock dams (**Kittleson 2015b**).

17. Aptos Lagoon should be closely monitored for unauthorized sandbar breaching, juvenile abundance and water quality. Install educational signs that explain the importance of leaving the sandbar alone once it naturally forms in summer. Individuals who illegally breach the sandbar in summer should be prosecuted.

18. Develop an Aptos Lagoon management plan with minimal sandbar manipulation, which protects residential and commercial property, as well as the important fishery value of the lagoon.

19. In the Corralitos Creek watershed (especially in the Eureka Gulch sub-watershed), identify the sources of sedimentation stemming from the Summit Fire and institute erosion control and revegetation measures to reduce future sedimentation.

20. Carry out a study to examine the passability of the Pajaro drainage to out-migrant smolts and in-migrant adult steelhead to and from the Corralitos sub-watershed. If passability proves to be difficult in drier years, as appeared to be the case in 2014, develop a program of well pumping, water diversion and aquifer recharge that is compatible with successful steelhead migration. Incorporate solutions into the Pajaro Valley basin management plan.

21. The sandbar at the mouth of the Pajaro River should continue to be allowed to close naturally as flows decline in summer. Artificial breaching should be prohibited in summer as is currently the case.

22. Spatial heterogeneity should be protected in the Pajaro Lagoon/estuary along the lagoon margin with overhanging riparian vegetation. Slackwater areas with overhanging riparian vegetation should be allowed remain to provide rearing and breeding habitat for tidewater goby during the dry season. Tule beds are valuable rearing habitat and provide winter refuge. Natural training of the Pajaro River outlet channel to the east, as occurs at other local creek mouths, results in a long lateral extent of the summer lagoon to the east of Watsonville Slough. This is significant summer habitat along the beach berm for tidewater goby and arrow goby when submerged aquatic vegetation is present.

23. Emergency breaching of the Pajaro River sandbar for flood control should be minimized. Breaching should be done so that lagoon draining is as slow as possible, leaving a maximum residual backwater depth in the estuary afterwards. Breaching on an incoming tide as high tide approaches will encourage this. It may be infeasible to cut the notch in the sandbar with heavy equipment on the beach near high tide. The notch may be cut ahead of time, as is done at Soquel Lagoon prior to emergency breaching. A berm may be left at the upstream end of the notch at the lagoon margin, which may be breached with hand shovels at the appropriate time if access with a loader is infeasible. Pursue projects that will reduce the need for emergency breaching.

24. Add County streamflow monitoring sites that would better supplement the fishery work. Add sites in Bean Creek near fish sampling sites, as well as more mainstem San Lorenzo sites below Kings, Boulder, Love and Fall Creek confluences. Measurements in the fall, as well as ones in early summer are important. The SLVWD has established temporary stream gages on Zayante, Boulder and Fall creeks as part of a streamflow monitoring project.

Branciforte Creek Flood Control Channel

Barker Dam on the middle mainstem San Lorenzo River− Reach 9
(below Boulder Creek confluence at Spring Creek confluence).

Flashboard Dam Remnant (Mainstem San Lorenzo above Bear Creek Confluence)

Highway 9 Culvert and Concrete Apron at Waterman Gap on the San Lorenzo River.

Flashboard dam on Bear Creek, downstream of Lanktree Bridge.

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APPENDIX A. WATERSHED MAPS.

Figure 1. Santa Cruz County Watersheds.

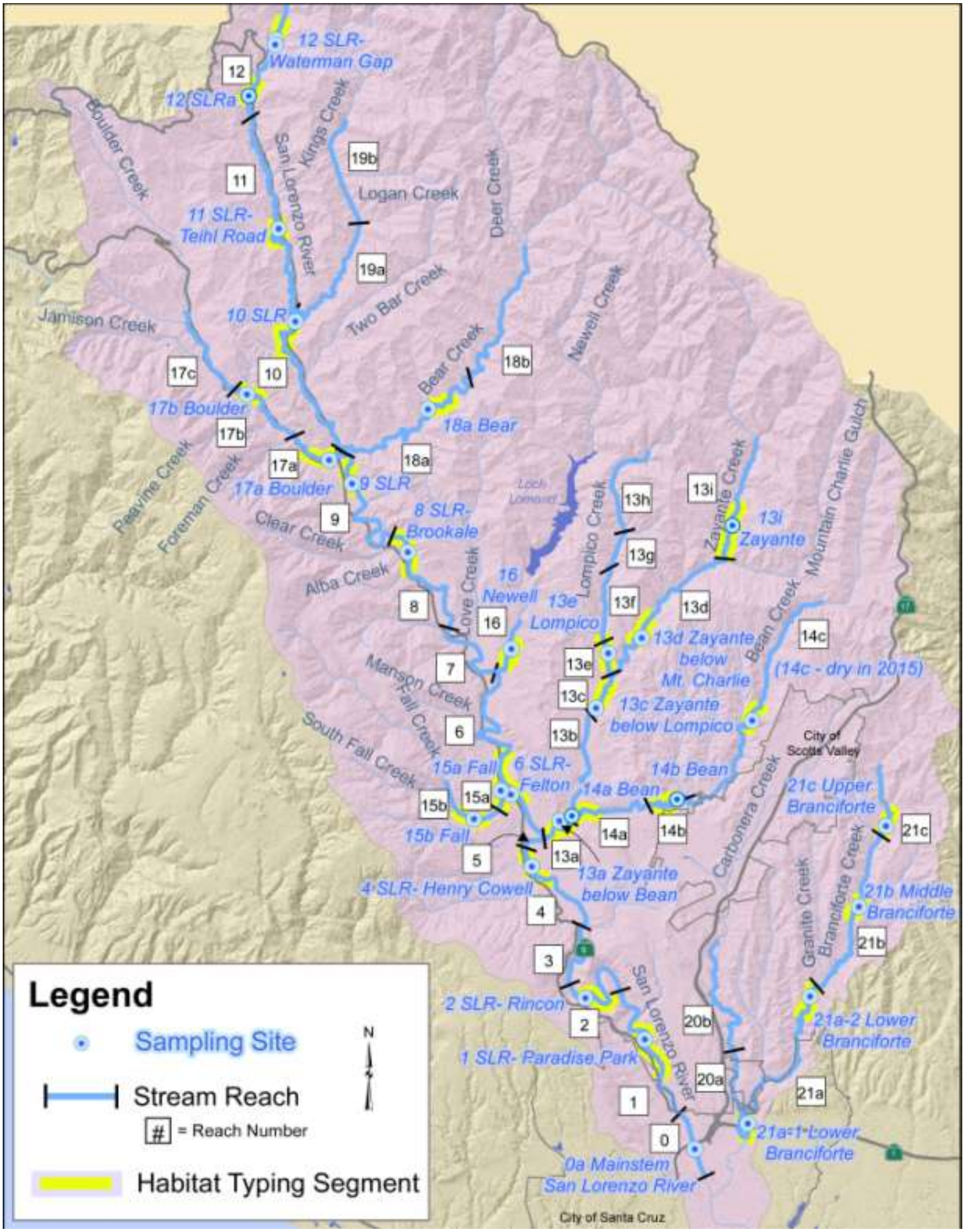

Figure 2. San Lorenzo River Watershed– Sampling Sites and Reaches.

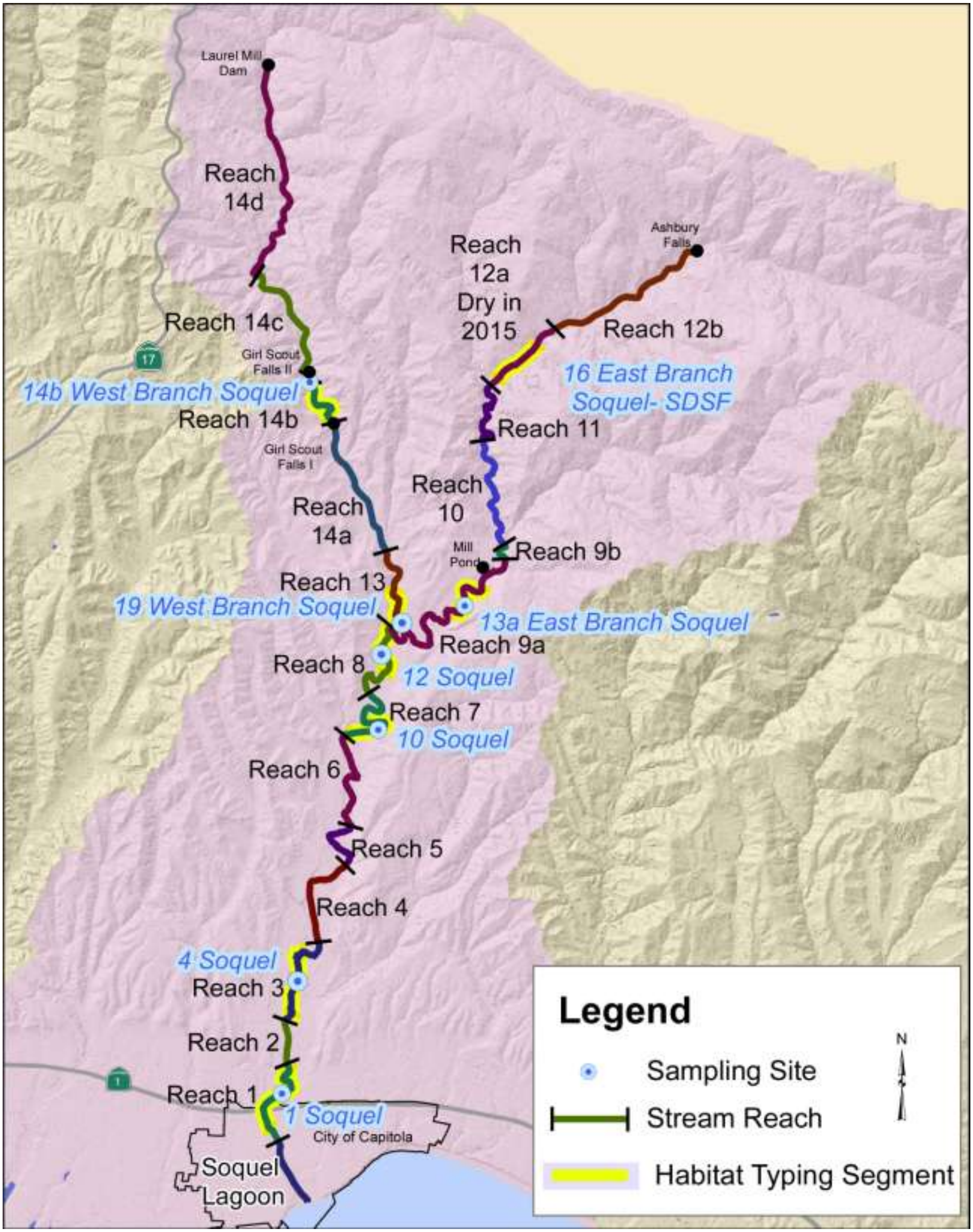

Figure 3. Soquel Creek Watershed.

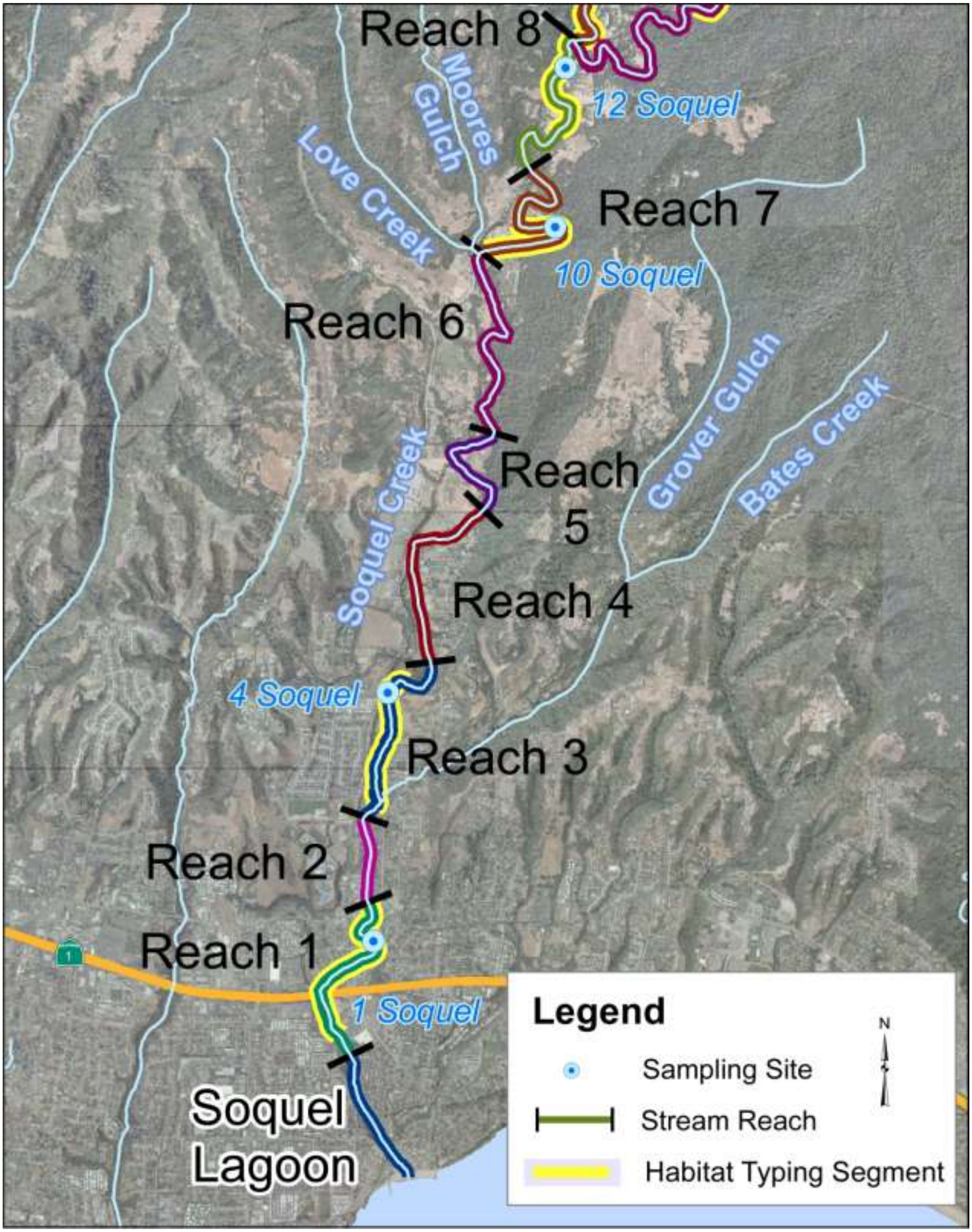

Figure 4. Lower Soquel Creek (Reaches 1–8 on Mainstem).

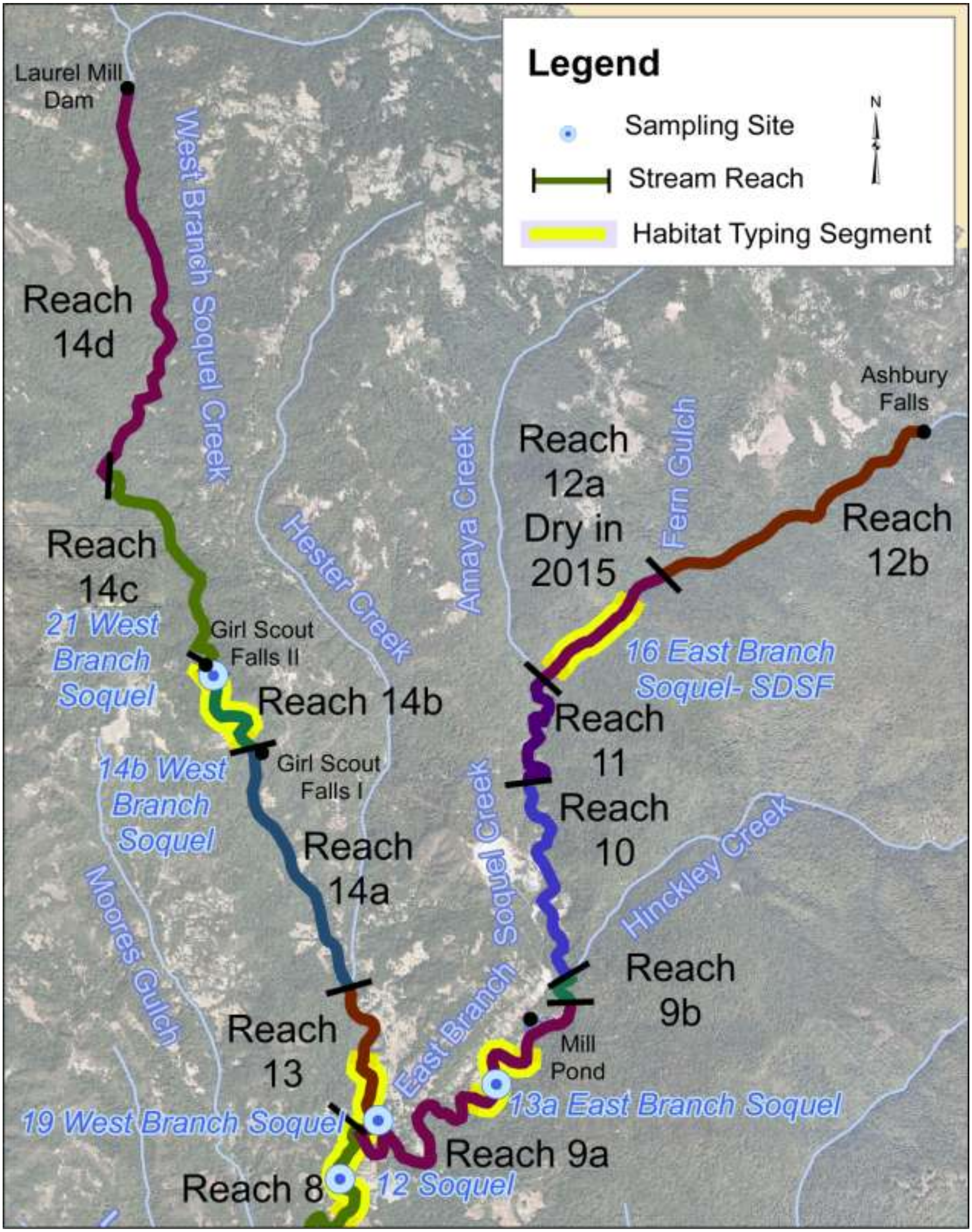

Figure 5. Upper Soquel Creek Watershed (East and West Branches; Reach 9a below habitat-typed segment and Reach 12a were dry in 2014 and 2015).

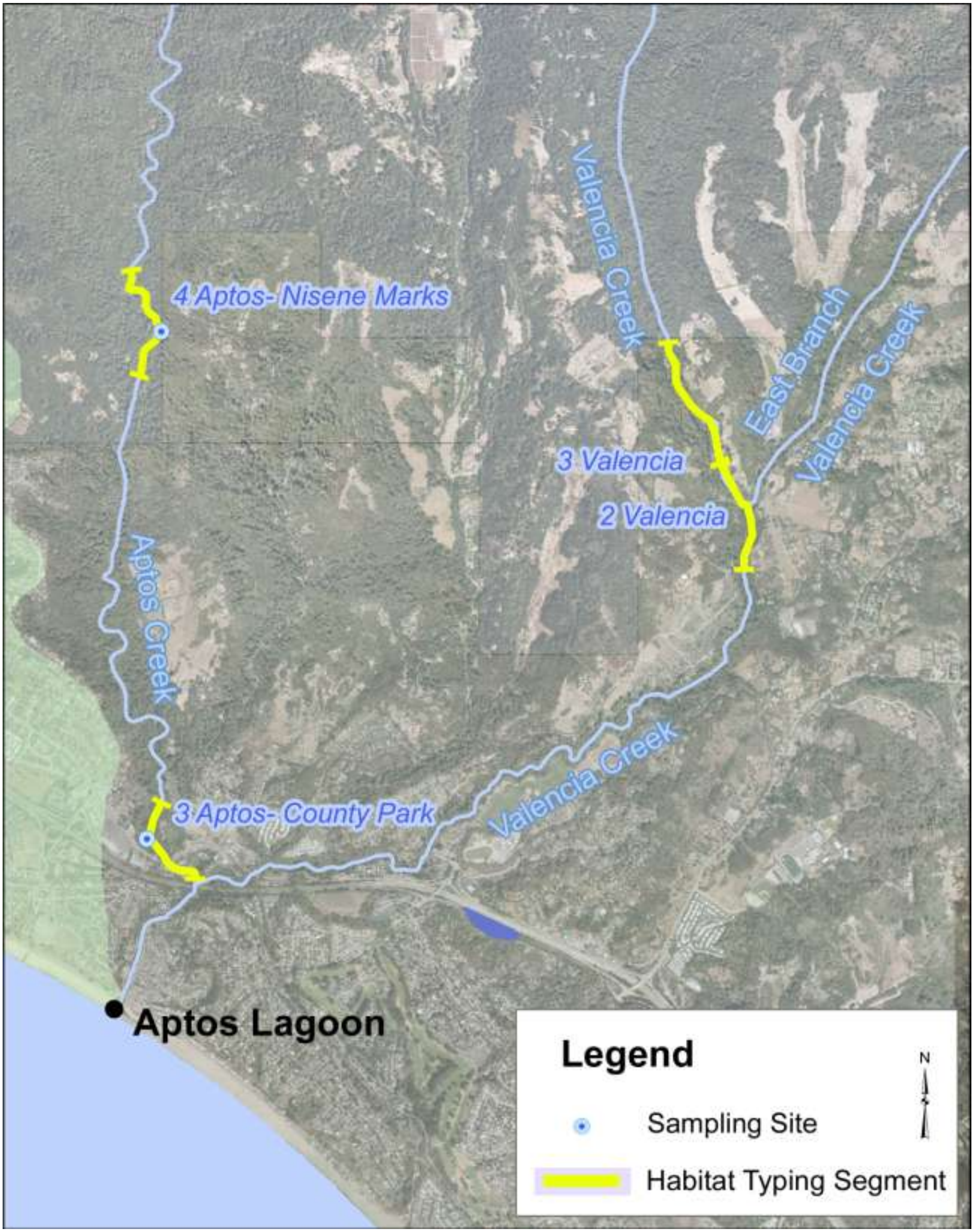

Figure 6. Aptos Creek Watershed (Aptos Lagoon and Valencia not sampled in 2015).

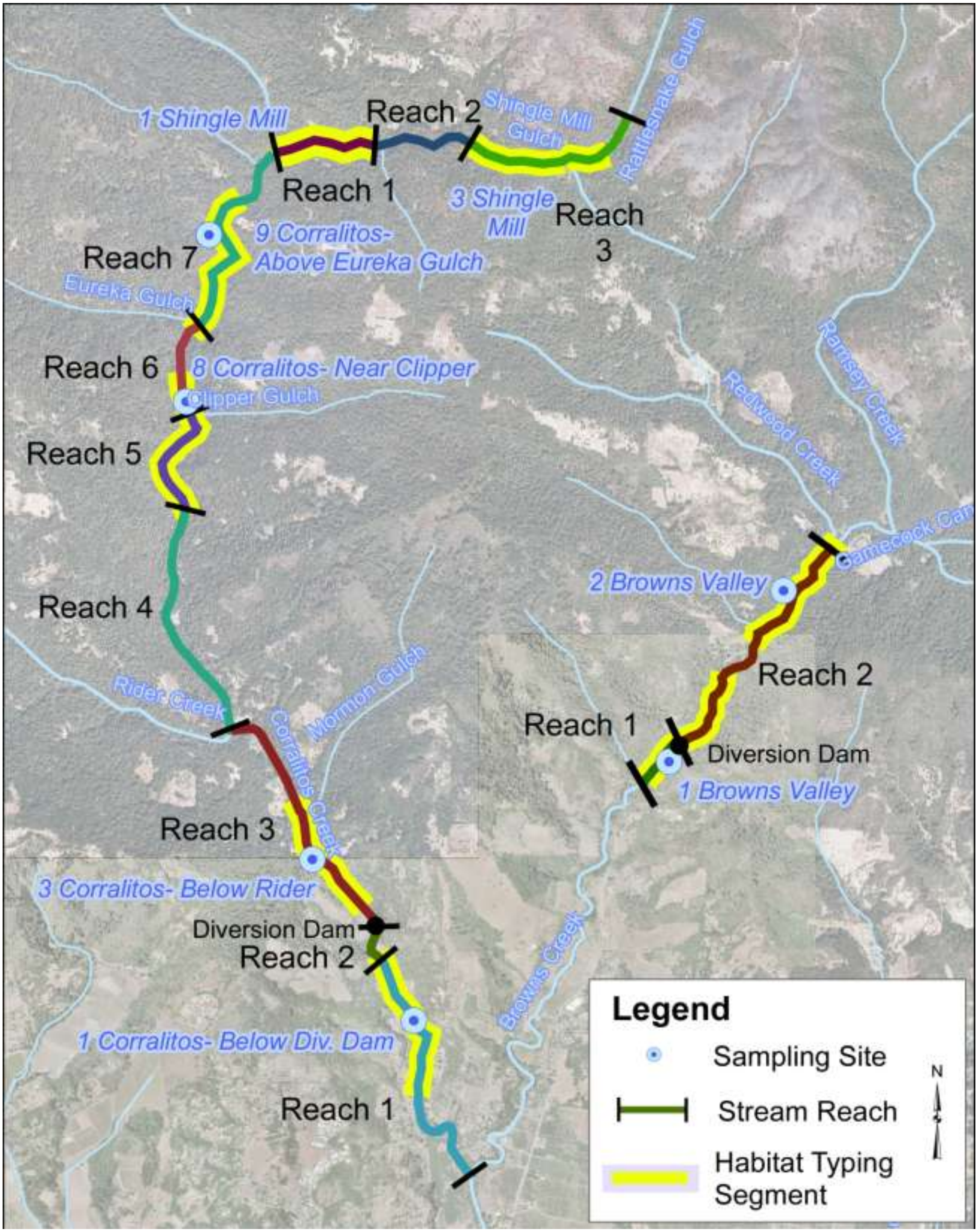

Figure 7. Upper Corralitos Creek Sub-Watershed of the Pajaro River Watershed

APPENDIX B. DETAILED ANALYSIS OF 2015 STEELHEAD MONITORING IN THE SAN LORENZO, SOQUEL, APTOS AND CORRALITOS WATERSHEDS

(Provided electronically in a separate PDF file.)

APPENDIX C. HYDROGRAPHS OF SAN LORENZO, SOQUEL AND CORRALITOS WATERSHEDS.

(Provided electronically in a separate PDF file.)